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A TREATISE

ON

LOCAL ANÆSTHESIA;

CONTAINING A BRIEF HISTORY OF SOME OF THE AGENTS EMPLOYED, WITH A DESCRIPTION OF THE MANNER OF THEIR USE.

BY

H. H. HOWE, M.D.,
FORMERLY EDITOR OF "ABSTRACT AND INDEX."

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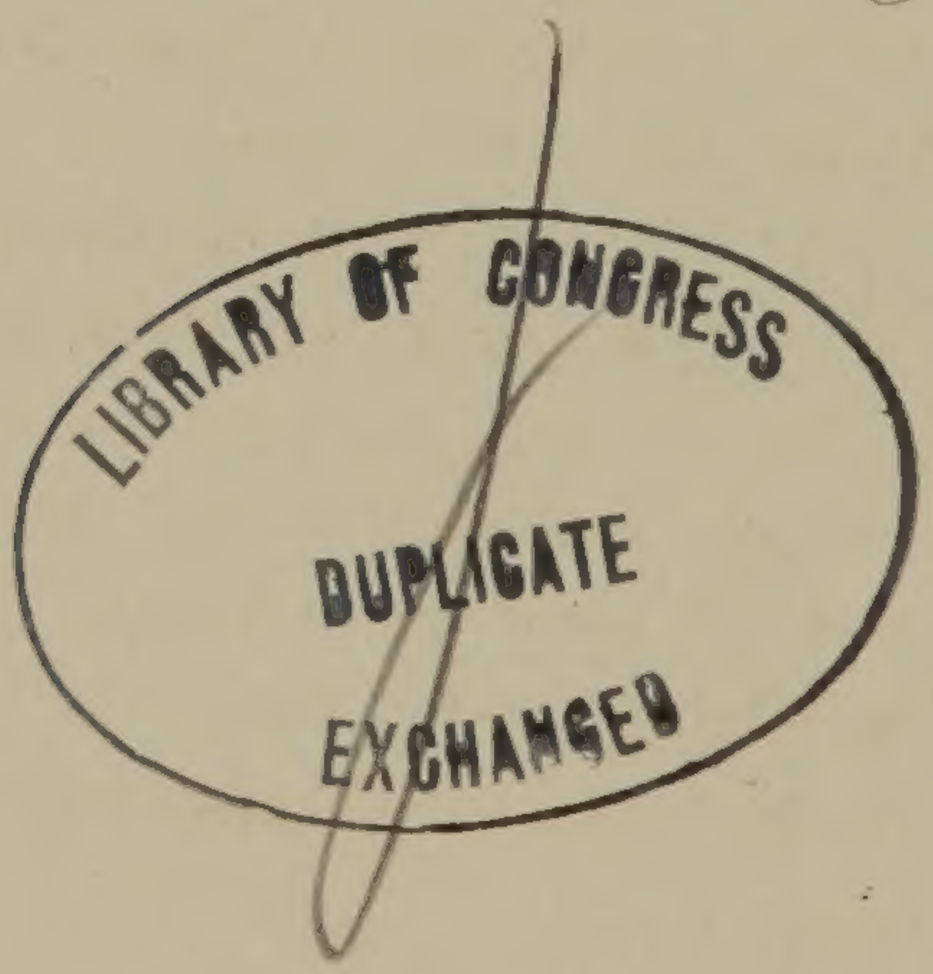
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PREFACE.

Being frequently called upon to do surgical work and finding with many others that general anæsthesia in minor surgery [illegible] very far from satisfactory, not because of accidents, but because of the average length of time necessary to secure an anæsthetic condition; the necessity of closely watching the patient while doing the operation, or of securing assistance which is very inconvenient many times and always necessitating a delay; the vomiting, and in many cases the continued nausea, and general disagreeable after-effects of the anæsthetic, all these argue against general anæsthesia.

To avoid that which was disagreeable to the patient, his friends and myself, my attention was turned to local anæsthesia, a subject which has received but little attention from the profession, and in looking for a work that would give one information on these lines I found that none embodying the latest views on this subject were to be had. Therefore, I make no further apology for the appearance of this book, which although not a complete treatise, yet we feel assured that it contains that information which will enable the practitioner to make successful use of local anæsthesia, and thereby save his patient suffering, save time to himself and increase his usefulness in surgical practice.

Weston, Vt., June, 1894.

LOCAL ANÆSTHESIA.

ANÆSTHESIA. Absence or loss of sensation, whether local or general, pathological, or purposely induced by anæsthetics.

LOCAL ANÆSTHESIA. Absence or loss of sensation in a portion of the body or limbs, and not general, this state or condition being induced by the use of some agent applied to the surface, or introduced within the part hypodermically.

The idea of annulling pain in surgical procedures it would seem, is a very old one. Among the first recommended to be used for this purpose, we find that compression of the nerves and blood-vessels by the application of a broad bandage was advocated, and also the inhalation of the vapour of mixtures said to contain carbonic anhydride were practiced at an early date. In the sixteenth century æther was probably the active ingredient of a volatile anæsthetic described by *Porta.

*Quain's Dictionary of Medicine. 1884. p. 40

The action of these various anæsthetic agents not being understood, they were seldom used, even the suggestions made by Sir Humphrey Davy, advocating the use of nitrous oxide as an anæsthetic in surgical operations, which would not be attended by the loss of much blood, received but little attention, presumably from the fact that no suitable apparatus was to be had for its proper administration.

In the year 1845 Horace Wells, from his success with this agent, may be said to have introduced it to use, although he met with repeated failure in his attempts to successfully produce anæsthesia. The introduction of æther, in the year following, 1846, diverted the attention of surgeons from this valuable agent, and it for a time, at least, fell into disuse. The introduction of æther by Dr. Morton, in this country, was followed by the introduction of chloroform, in the year 1847, by Dr. Simpson, in England, and painless surgical operations became a realty instead of a dream.

Since this time, various substances have been introduced to the profession for the purpose of supplanting æther and chloroform; agents that could be used for the production of the anæsthetic condition with perfect safety to life, but so far, experience with all of these various substances, have shown that to meet with success in all cases, one must select his patients, and observe with due care, certain facts in regard to the action of the agent used, and the physical condition of the patient at time of operation. Recognizing these facts to be true

in regard to general anæsthesia, the attention of surgeons has been directed to the finding of some agent or means for the obtaining of an anæsthetic condition locally, for the purpose of performing minor operations without the giving of the patient pain.

We believe the first agent used or tried for the purpose of obtaining local anæsthesia was pressure upon the nerve or blood-vessels, or both, by means of a broad bandage tightly applied in the immediate neighborhood of the site of the proposed operation. This as is easily to be seen, did not give freedom from pain, therefore we find but little in medical literature which refers to this manner of procedure.

The application of cold as an anæsthetic to the part to be operated upon was tried with a greater degree of success. The manner of applying cold was by the use of finely-pounded ice and salt, mixed and enclosed in a muslin bag, bladder, or metallic receptacle, and applied to the part which was to be operated on, and allowed to remain for from one to five minutes, when the part was found to be frozen, and incisions could be made in the skin, and the tissues immediately beneath, without giving any pain. This process was known as "Dr. Arnott's method of anæsthesia."

*"As no remedy has been longer in use, and few are more valued than the local application of moderate degrees of cold, or a temperature ranging from that of dissolving ice to about 70° of Fahrenheit, it may at first

*Braithwaite's Retrospect, Part xxx, p. 247.

appear singular that a greater or more powerful remedial effect should not have been sought by increasing the dose of the agent, or employing a lower temperature, in the same manner as we have sought and found much greater remedial benefit in many cases by using mercury, antimony, and other drugs, in larger doses than had been customary. The reason is that medical men were under a most erroneous impression respecting the effects of very low temperatures on the body. Because a temperature of zero stops the circulation, and because the vitality of a part has been lost by its *long-continued* congelation, whether caused by exposure to severe cold in winter, or by the incautious use of ice in hernia and other diseases, it was hastily and erroneously inferred that there was danger of loss of vitality from *short-continued* congelation. The mistake would not be greater to infer from the fact, because a long-continued stoppage of the circulation through a limb from an improper application of a bandage has occasioned gangrene, that it would be dangerous to use the tourniquet in operations.

The correction of this error will be deemed of no little importance, when it is considered that in short-continued congelation, judiciously applied, we have an unfailing means of immediately arresting inflammation wherever it can be reached by the remedy; of not only giving speedy relief from pain in many diseases, but in consequence of the organic changes produced by it, of obviating the return of pain; and in malignant disease,

of producing an amount of benefit much exceeding that yet accomplished by other means. Although much inferior in importance to these results, it is yet another great benefit conferred by intense cold, that the pain which would be otherwise caused by the greater number of surgical operations, can be prevented by it with perfect safety; and not only can pain be prevented, but the inflammation proceeding from surgeon's knife, that so often proves fatal, may also be obviated by the same means, and with almost equal certainty. It will be proper to consider the remedial and anæsthetic effects of intense cold separately; but before doing so, it is necessary to mention how this degree of cold is produced and applied, as well as to attempt an explanation of its mode of operation.

That degree of cold may be called intense which immediately benumbs the part to which it is applied, speedily stops the circulation through it, and congeals the adipose matter. I have usually produced these effects by placing what are termed frigorific mixtures, either immediately in contact with the skin or mucous membrane, by means of a net of thin ganze containing them, or by allowing them to act through thin bladders, or metallic vessels of appropriate form; but there are various other ways of effecting the same object, some of which are preferable for certain purposes. Substances passing rapidly from the solid to the fluid, or from the fluid to the aeriform state, strongly abstract caloric from other bodies in contact with them;

and substances, either solid, fluid, or aeriform, already sufficiently cooled by artificial means, may be placed in contact with the part; the first, as solid metallic balls of appropriate shape; the latter two, when forming strong currents. When cold is produced by the common frigorific mixture of ice and salt, and applied by means of a gauze bag or net, the following is a convenient mode of proceeding:—If the congelation is not to be extensive, or long-continued, a piece of ice of the size of a large orange will be sufficient. This is well pounded in a coarse cloth or bag, and the powder being placed on a large sheet of paper, is thoroughly mixed, by means of a paper-folder, with about half its weight of common salt. The mixture is then put into a net of about four inches diameter, and as soon as it begins to dissolve, it is ready to be applied. The net is not kept motionless on the part, but is frequently raised, in order that fresh particles of the mixture may be brought into contact with the skin; and the water that escapes from it may be absorbed by a sponge, or allowed to fall into a basin placed underneath. If the surface to be acted upon is of small extent, a very thin and large copper spoon containing the mixture, or a solid brass ball of about a pound weight, which has been immersed in ice and salt, will often answer, and be a neater mode than the net.

The moment a gauze net, or a thin metallic vessel containing ice and salt, is applied to the skin, it is benumbed. There is hardly a sensation of cold produced, and no tingling or smarting. If the contact of the

frigorific be continued a few seconds longer, the surface becomes suddenly white, in consequence, doubtless, of the arrest of the circulation; and this change of colour is attended with a slight smarting like that produced by mustard. There is now complete anæsthesia, which, if the frigorific were removed, would remain complete for several minutes. But if the frigorific be allowed to act, another change is produced — the adipose matter under the skin is congealed, and the part becomes hard as well as white. The depth to which the benumbing influence of cold will extend depends upon a variety of circumstances, as the degree of cold, the duration of the application, the vascularity of the part, whether pressure is used or the circulation is suspended, etc., etc. After the usual application of cold for anæsthesia, the circulation soon returns to the part, and the skin assumes a red colour which lasts for several hours. If the congelation has been considerable, there is now some smarting felt, unless the natural heat be more gradually restored by pouring cold water on the part, or by placing on it a little pounded ice, or a bladder containing iced water. If the application has not exceeded the first stages, there is no smarting, and no necessity, therefore, for such precautions.

The redness produced does not, as might at first sight be supposed, indicate an inflammatory condition, but the very reverse. The tonicity of the small arteries appears to be lessened or suspended for a time, and instead of being inflamed, the part is rendered unsuscep-

tible of inflammation. Parts cut after congelation heal by adhesion, or the first intention more quickly than they otherwise would; and, as has already been said, we possess in this expedient a certain and prompt remedy for every inflammation accessible to its complete influence."

We give a report of a few cases showing the results of this procedure:

*"Mr. Paget excised a fatty tumor from over the shoulder of a lady, the skin having previously been frozen; and although the incision required was four inches long, yet no pain was complained of. In proof that congelation does not hinder the subsequent healing, it may be mentioned, that in that instance a considerable part of the wound united by the first intention, and the rest of it soon closed. The mixture used was about equal parts of pounded ice and salt, enclosed in a coarse muslin bag. This was by degrees applied to the surface to be operated on, and, as the patient got used to the sensation, allowed to remain on it. The process occupied from four to six minutes, and caused no pain."

The following *case, by N. Wood, Esq., is illustrative of the value of this anæsthetic agent:

"I was consulted a few days back by a gentleman between 30 and 40 years of age, of a highly nervous temperament, concerning a tumor situated over the right clavicle, and which required removal. It was just one of those cases in which a surgeon, on the one hand,

*Braithwaite's Retrospect. Part xxx. p. 253.

would not have sanctioned the use of chloroform, and on the other, in which the patient would have protested against anything being done unless it could be accomplished without pain. The tumor was of a sebaceous character, as large as a walnut, had been gradually increasing for two or three years, and gave him inconvenience during every movement of the arm. On informing my patient that chloroform (to which he was so much averse) would be attended with risk, but that the removal of the tumor could be effected with safety and without pain by the previous application of cold, his nervous anxiety subsided, and he consented to the operation.

I mixed together two parts of pounded Wenham-lake ice and one part of salt, and put them in a common white pocket-handkerchief, and kept the mixture pressed on and around the tumor during the space of one minute by the watch. The integument that was submitted directly to the action of the cold became remarkably corrugated. It was then cut into, and the tumor removed without the slightest sensation of pain, and much to the astonishment and delight of the patient, who said that the only thing that annoyed him, and that not much, was the burning sensation of the application. No vessel required ligature, the bleeding, in fact, being very trivial, and the wound had healed at the end of the week."

The following case of cataract operation which was rendered painless by the use of cold as a local anæs-

thetic was reported by George Critchett, Esq., in *Braithwaite's Retrospect.* Part, xxx. p. 184.

"Some pounded ice was put into a bladder, mixed with salt, and placed over the right eye, temple, cheek, and brow, and kept there for about twenty minutes. At the end of that time, all sensation being lost, I made a rapid section of the cornea, which was immediately followed by the cataract and some portion of vitreous humor. Some slight hemorrhage occurred, but slowly, and not to an extent beyond half an ounce. As sensation returned, our patient complained of extreme soreness and discomfort about the eye, and some of the old pains, taking the course of the fifth pair of nerves, came on. All this, however, speedily subsided, and we had the satisfaction of seeing him in a few days quite free from pain, the section of the cornea gradually approximating, and with every prospect of a speedy and complete recovery, without fear of relapse, now that the cause of all the suffering was removed.

It seems to me that the application of cold fulfilled, in this case, all the indications that were desired, and from the slight hemorrhage that occurred, and from my previous experience of somewhat similar cases, I am of opinion that if the operation had been performed without local anæsthesia, there would have been very severe pain at the time, extensive bleeding, consequent painful distention of the globe, and a tedious recovery."

The following cases reported by Dr. W. V. Pettigrew, (*Braithwaite's Retrospect.* Part, xxxi. p. 297.) show-

ing the results which he obtained by means of cold as a local anæsthetic.

"J. T., Wilton-street, aged 52. Fatty tumor of five years' gradual growth, in the popliteal region, about the size of an orange. Had been presumed to be an aneurism, an enlarged gland, and an enlarged ganglion, the characteristics of each of which, however, were wanting. I obtained some rough ice, had it very finely powdered, and added what I presume to be sea-salt, in the proportion of 2 pints ice to 1 of salt. This was placed in a thin muslin bag, and applied closely over the popliteal region. In one minute and three-quarters the part was hard, very white, and had the appearance of a washerwoman's hand. The tumor was removed in half-a-minute, and two ligatures brought the edges of the wound together. Strapping and a bandage were applied; about ten drops of blood lost; no sponging required, or vessel to be tied, although the lobules of the tumor dipped deep. Not the slightest sensation of pain was experienced, and as the patient was deaf, and lay upon his stomach, and could not see what was going on, it was a fair case. I was assisted, and timed, watch in hand, by F. Pettigrew."

"M. A. C., Belgrave-square, aged 26; highly nervous temperament. Solidified ganglion over the patella of the right knee; strongly adherent to the skin and of three years' growth. Informs me that it has been blistered for the last twelve months; no pain, but very inconvenient. Ice and sea-salt in same proportions as in

the last case. Frosted in two minutes and a-half. Operation lasted nearly two minutes, as the adhesions were so strong it was like carving out a solid ball from the skin. No pain was felt during the long incision through the skin, nor in detaching the tumor from the sides; but the separation from the patella was felt, although not so acutely as under other circumstances. Two ligatures were run through the integuments; strapping and bandage; not above twenty drops of blood lost.

As far as I can judge from these two cases, I should say that at least two-thirds of the operations performed under chloroform may be dispensed with, the cold application is so simple and so rapid in its action. As to the pain of the application,—at first it appears hot, then tingling, and sensation is altogether lost after this. The ice must be most finely pounded. I did it in a towel, banging the ice with a weight; if it is not well pounded, the part will evidently not be equally frozen, which accounted for Case 2 taking two minutes and a-half to freeze; neither should too much ice be put in the bag, as a thin layer can be more easily placed under a projecting tumor."

In regard to the use of cold as an anæsthetic agent in many cases, *Thos. Wakley, Esq., says: "I have tried ice in several cases, in both hospital and private practice, and in almost every instance the success was evident, the patient when blindfolded being ignorant of the

*Braithwaite's Retrospect. part xxxi. p. 263.

use of the knife. It affords me great pleasure to confirm the evidence of Dr. Arnott upon this interesting subject, and to draw the serious attention of surgeons, both at home and abroad, to this agent, whereby patients can be freed from the pain which attends many every-day operations we are called upon to treat with the knife, and reserve chloroform for those very severe cases where either the duration of the operation or the depth of structure requires the employment of that potent agency."

The application of cold to the surface or the purpose of benumbing the part, as may be seen from the foregoing was first accomplished by means of ice finely divided and mixed with salt enclosed in a muslin bag, or a metallic container placed on the part, but, as there were cases in which this manner of procedure did not destroy the sensation in a satisfactory degree, other means were sought after with the hope and expectation that with a change in the manner of producing the degree of cold necessary for thoroughly benumbing the part, that a greater number of the patients would be freed from pain at the time of operation.

The attention of surgeons was then turned to liquids which would quickly evaporate, or change from the liquid to the aeriform state on exposure to the air, and in that way abstract the latent heat and congeal the tissues with which they were brought in contact. The results were about the same, although in some cases the anæsthetic condition could be induced and continued with

greater facility than with the ice and salt mixture.

The following case reported by D. Cheize, in *Braithwaite's Retrospect*. Part, lxxxviii. p. 280, shows the results obtained in a case of ingrowing toe-nail.

"Wishing to remove an ingrowing toe-nail, and being without a spray producer, he covered the toe with a pledget the size of a crown piece, poured ether on it, and evaporated this by means of a pair of bellows; in five minutes anæsthesia was complete and lasted while the nail was removed, and the matrix seared with the actual cautery."

The usual method of using ether for producing local anæsthesia was by using a spray apparatus having metalic tubes, and directing the spray upon the part until the degree of congelation desired was obtained. In some cases the part to be operated upon was frozen by the use of the spray just in advance of the knife, or scissors, this enabled the operator to remove a cancerous growth or a tumor, not within the abdominal cavity, without giving pain.

The following case of excision of a cancerous breast by scissors-cutting under ether spray is reported by Dr. B. W. Richardson.*

"A lady, æt. fifty, consulted him in April last, with a hard scirrhous tumor of her left breast, loosely held in the gland. The propriety of removing it while yet easily movable was apparent; but then the question of the admintstration of an anæsthetic came under con-

* Lancet, Aug. 29, '74. American Jour. of the Med. Sciences, Oct. '74.

sideration. The action of the heart of this lady was so intermittent and irregular, and the power of her heart was so reduced, that the slightest external impression influenced it in its motion. She belonged, in a word, to that population which is prone to die suddenly from chloroform and other narcotic vapours.

Under these circumstances Dr. R. proposed that the tumor should be removed by local anæsthesia, and, accordingly, he operated on the 8th of May in the following manner:—

The patient having been placed in a semi-recumbent position on a narrow couch, I directed Mr. W. Perkins, who very efficiently conducted the local anæsthesia, to direct gently over the tumor a large spray of common ether, so as to chill thoroughly but not to freeze the skin. I let him maintain this for a period of five minutes. Then I handed to him another tube and bottle for spraying over the already chilled part the light fluid called anæsthetic ether — a compound of ether of sp. gr. .720 with hydride of amyl. A few moments' application of this lighter ether was sufficient to render the whole of the breast frozen like a hard snowball. For a minute longer, that the deeper structures might become equally chilled, the spray was continued. When the structures were thus prepared, instead of using a scalpel for cutting, as in the ordinary way, I made the required incisions through the skin with a pair of small, strong, sharp, slightly-curved scissors. Commencing the incision by an angular cut at the outer margin of

the part to be excised, I carried the lower blade of the scissors deeply into the breast with the edge of the blade everted. In this way I cut the lower flap; then, commencing at the same angle, I cut in the same manner the upper flap. The rapidity and ease with which these incisions through the hardened tissues were made struck me most favorably. The incisions were deep enough to enable me to grasp the tumour firmly with the left hand. I now laid down the ordinary sharp-cutting scissors, and with a pair of strong, slightly-curved, tooth-edged scissors, I proceeded to cut on each side of the tumour until I could fairly lift it up; then, by a few strokes made with the same scissors underneath, I cleared it completely away. The operation lasted precisely three minutes, and was unattended, during the whole time, by the escape of blood. The diseased mass removed, I had the ether spray withdrawn, in order to see if any vessels would bleed during reaction from the freezing. There was a little oozing of blood, which quickly subsided, and one artery was tied, and both ends of the ligature being cut off close to the vessel. The wound, carefully cleaned with a soft, damp sponge, was closed; the edges of it were secured with five sutures; a pledget of cotton-wool, charged with *styptic colloid, was placed over the wound; and a lint-pad and firm bandage completed the dressing. The patient passed

*Styptic Colloid.—Collodion, 100.0; Carbolic acid, 10.0; Tannic acid, 5.0; Benzoic acid, 5.0. Mix the ingredients in the above order. It instantly coagulates blood, forming a consistent clot under which wounds will readily heal.

a good night after the operation. She was allowed to rise and go into the drawing-room on the following day; and as she exhibited no rise of temperature beyond 99° Fahr., and that only for a few hours, and suffered from not one untoward symptom, the dressing was left untouched until the 13th of May, when, on removing it, the wound was found healed throughout its entire extent. The sutures were removed a few days later, when the line of incision was found fairly closed, without a particle of discharge or interruption of healing at any point.

During the operation the patient did not utter a single expression of pain, and afterwards stated that 'during the application of the ether spray the local feeling was that of gradually becoming cold, as in frosty weather, just as when the hands go numbed, but there was no actual pain. Felt pressure when the scissors went into the tumor, and experienced a kind of a jar, but did not feel anything like an incision, and, in fact, was not aware when the incisions were made. Felt nothing of the next part of the operation, but when the tumour was held up and divided by three long cuts, experienced a feeling, not of pain, but as if the parts were put on a stretch or dragged; did not feel the tying of the ligature, but when some small substance (a bit of loose fatty tissue) was cut off felt again as if the parts were being stretched. When the sutures were introduced felt the pressure whilst the flaps were being held together, but was unconscious of the prick of the needle.'

In all respects this operation was, as an operation, completely successful, and one other success followed it Dr. R. did not expect. As the recovery from the excision progressed the irregular action of the heart became less marked, and ultimately disappeared altogether. In the month of July this lady called upon me, and was found to be restored to perfect health.

Soon after the recovery of the above-named patient another lady came under Dr. R.'s care, with a scirrhous tumour in her breast. In this case again the question of the administration of chloroform or some other anæsthetic vapour pressed for careful consideration. The patient had been declared by one of her medical friends to be suffering from disease of the heart, and had been urged by him in most forcible terms not to subject herself to general anæsthesia. Another medical friend, in less determinate but still serious expression of opinion, gave her similar advice. She herself had read of the danger she heard described, and her anxious dread alone was all but sufficient to preclude the administration of any narcotic vapour. On examination of the heart Dr. R. found exceeding feebleness of action, an irregular and often intermittent beat, and at the apex a soft systolic murmur. Under these circumstances Dr. R. advised the removal of the tumour under ether spray, which he did on the 23d of June. The steps of the operation were the same as in the preceding case.

'This patient, like the last, bore the operation perfectly. She felt no pain from the incisions, and although

the deep dissection which was required to remove the tumour from its attachment was felt as a severe drag or pull, it gave rise to no evidence of acute pain. The act of sponging the wound, and the insertion of one of the sutures, caused momentary expression of pain, but on the whole, she was throughout brave, perfectly collected, and as quiet as if she had been asleep. This patient, like the previous one, progressed so favourably that she was allowed to get up every day. On the fourth day after the operation, as she complained of the pressure of the pad, I removed the dressing, and found the wound freshly healed throughout its entire length, without a trace of suppuration. In this act, however, a little misfortune occurred. A portion of the cotton wool adhered firmly, through the styptic colloid, to a loose end of the upper suture, and, while I was extricating the wool, an accidental movement of the patient caused the ligature to tear out of the upper lip of the newly-joined skin. From this slight point there followed as much as a drachm and a half to two drachms of bright-red very thin blood. I stopped this bleeding, not very readily, by firm pressure with styptic wool; but a little further bleeding took place during the day beneath the compress and into the subcutaneous tissue, and gave rise to a superficial sore about the size of a sixpence. On the eighth day after the operation the patient was able to go out of doors, and but for the slow healing of the small sore whence the hemorrhage pro-

ceeded at the first dressing of the wound, recovery rapidly succeeded.

'One other fact closely connecting this with the preceding case is worthy or particular notice. As this second patient began to rally from the operation, the distressing cardiac symptoms entirely passed away, the stroke of the heart improved in tone, the irritability ceased, and the faint murmur became imperceptible.'

Dr. R. makes some interesting comments on the facts above recorded.

'1. *As to the effect of the local anæsthesia.*—This in both the cases afforded everything that could be desired in the way of anæsthesia. It saved all acute pain; it saved the patient the dread of death during the insensibility from a general anæsthetic, and it enabled me to proceed in our task without a thought as to the immediate safety of the patient. I may say more for it still. It warranted me in recommending the operation. I should certainly not have advised any friend of mine, whose heart was in the same condition of irritability and irregular nervous supply, to inhale an anæsthetic vapour to the fatal effects of which such conditions of the circulation are so favourable.'

'2. *The method of cutting with scissors.*—Local anæsthesia has many disadvantages. It is more troublesome than general anæsthesia as a detail of practice, and, as it leaves the consciousness alive, it fails at times in preventing the fears of the patient. But hitherto the greatest difficulty in operating under it has been the

obstacle of cutting through the hard, frozen, insensible part. The resistance to incision by the best cutting, and especially to dissection by the knife, is such that I have seen the most skilful surgeons troubled by it; and I have never been able to complain of the objection that has been made to the method, on this ground. The difficulty is now overcome by the process of scissor-cutting which I have here introduced. The advantage of the scissors over the scalpel will be at once proved by anyone who will take a thick, firm structure — the cover of a book for example — and try to cut through it. With the best of scalpels he will be troubled; but with scissor blades he will cut with the utmost facility, if the blades be well set. So, in cutting through the frozen animal tissue, the parts can be divided as rapidly as may be wished with the scissor blades, with perfect accuracy of incision, and as deeply as may be desired. The cutting is also made without any downward pressure, by which pain of pressure is saved. Also in deep dissection, the tissues, frozen as they are exposed, can be divided more easily than by the knife; for the harder they are solidified, the easier they are divided by the scissor blades. In a word, I believe that every cutting operation, in which local anæsthesia is practicable, may be performed neatly and effectively by scissor-cutting, and that a much larger number of operations may now be painlessly carried out under the local method.'

'Some little attention requires to be paid to the instruments used. The scissors for superficial or skin cutting

should be exquisitely sharp, neat, and strong; and I prefer them slightly curved. For deep cutting, where there are many bloodvessels, the tooth-edged cutters are valuable. These pierce, crush, and divide at the same time, and they save blood.' * * * *

'3. *The effect of the operation on the heart* I consider as extremely instructive. In both instances the cardiac irregularity and irritability were purely due to irregular nervous supply—to nervous irritation and consequent muscular exhaustion. The irritation might have been in part due to the mental anxiety which naturally accompanies the disease, or it might have been due to the irritation of the tumor, and have been reflex in character. Whichever view be correct, the result of the operation was curative, and, as the cases are typical of a class of phenomena of disease, the lesson they teach is extended far beyond them as individual illustrations. They show that so soon as the heart obtains rest from the persistent nervous thrill that invades it, its muscular tone returns, and its irregular motion and excitability cease. Thus by operating early for the removal of cancer the surgeon acts as physician also, and prolongs the general life by removing the local disease. I am convinced I have seen patients suffering of cancer die from the mental and local irritation of the disease long before any development of the malady has advanced to kill by destruction of the part or organ involved. I infer, therefore, that if, without any danger to life from general anæsthesia, we can remove external malignant growths painlessly and

promptly, so soon indeed as they are detected, we shall bring art, effectively, to the defeat even of cancer.'

In the foregoing case mention is made of "anæsthetic ether" which was used following the first spraying with common ether. This was made by mixing one part of *amyl hydride with four parts of ether. The mixture being called "Compound anæsthetic ether for local anæsthesia." It is said to induce, in the form of spray, perfect insensibility of the skin in from ten to twenty seconds of time; but, in using this compound or any other that evaporates quickly care should be taken not to freeze the skin too rapidly, as the layer of frozen tissue acts as a non-conductor, and deeper freezing is thereby rendered difficult.

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*AMYL HYDRIDE, or RHIGOLENE. This name was given by Dr. H. J. Bigelow, of Boston, to a very light, inflammable liquid, obtained by distilling petroleum, and separating the liquids of the lowest boiling point by redistillation, until one is obtained which boils at about 18 deg. C. (64.4 deg. F.). It is not pretended that this is a peculiar definite compound; on the contrary, it is simply a fluid more volatile than any one previously known, and capable, consequently, of producing a greater degree of cold by its evaporation. In this respect rhigolene probably exceeds all other substances, with the exception of *cymogene*, which boils at 0 deg. C. (32 deg. F.). A degree of cold—9 deg. C. (15 deg. F.) is, according to Dr. Bigelow, obtained through the evaporation of this liquid by means of the common atomizer or "spray producer." This is the chief use of the liquid; which may be employed as a substitute for ether, and with still greater effect, in producing congelation of any part of the body preparatory to a surgical operation, or a great degree of cold for any other purpose. It should, when not in use, be kept in a cool place, in bottles tightly corked; as otherwise it will be rapidly evaporated. In a warm place it might break the bottles through its extreme volatility, unless the stopper should previously be driven out. It has been accused of being liable to explosion; but this is not true, unless the vapor should be mixed, in certain proportions, with atmospheric air, then approached by a burning body.— *United States Dispensatory*, 15th, edition. p. 1739.

In the using of compound ether, or rhigolene, care should be taken that the degree of intense cold be not continued in the part for any length of time as by so doing gangrene, or death of the part will be quite likely to follow.

The following case* shows the effect of the combined cold and slight incision in producing the anæsthetic condition.

"Dr. Letamendi (*Archives de Physiologie*) has discovered a new mode of utilizing the anæsthetic effects of ether spray.

Richardson's spray-producer is filled with rectified perfectly neutral sulphuric ether, and held at a distance of seven to eight centimetres from the skin on which the spray is directed. After about two minutes the part of the skin on which the spray has fallen becomes red, and is the seat of a disagreeable sensation of cold; there is no sensation of burning in the part.

If, at this moment, an incision eight to ten millimeters long is made with a convex bistoury in the centre of the reddened part, not being carried deeper than the papillary layer of the cutis, immediately the incision is made, there is suddenly produced an anæmic zone which enlarges outwards from the point incised, as a circle goes on enlarging on the surface of water on which a pebble has been dropped.

If the spray is again directed for a few seconds on the part which has thus become anæmic, the region be-

* Monthly Abstract of Medical Science. Vol. iii, p. 5.

comes perfectly bloodless and completely anæsthetic. The tissues when cut are like frozen fat, and have lost their elasticity. Around the white circle there is a zone in which the anæmia is not absolute. The spray directed on this zone speedily makes the anæmia and consequent anæsthesia complete. The anæsthesia can thus be carried around or along a limb.

The theory brought forward by Dr. Letamendi to account for the effect of the slight incision is, that the cold produced by the ether causes relaxation and consequently dilatation of the vessels. The incision produces a sudden reaction which converts the extreme dilatation into extreme contraction. The practical advantage of the incision is that anæsthesia is obtained without a prolonged application of the ether spray."*

Much in regard to the use of rhigolene as a local anæsthetic may be found scattered through the periodical medical literature, many operators giving it the preference over any other quickly evaporating liquid for the purpose of inducing an intense degree of cold, but, so far as is known its value is no greater than that of any other liquid, or combination of liquids, evaporating with equal rapidity. Rhigolene somewhat resembles † amylene, both being used for anæsthesia, amylene for general and amyl hydride for local.

Sometimes it is desirable to make use of a local anæsthetic after dark, or where it would be necessary to

* Monthly Abstract of Medical Science. Vol. iii. p. 5.

† National Dispensatory. 5th edition. p. 201.

have artificial light, and in such a case it would not be advisable to make use of any preparation containing ether on account of the explosiveness of the vapor.

"Terrillon* (*Bull. Gén. de Thérap.*, tome xcviii. No. 7) prefers bromide of ethyl as an anæsthetic to ether for local use, (1) because it can be used without danger after dark, being non-inflammable; (2) it has a very slight odor; (3) less is needed than when ether is used; (4) the wound is not irritated, and the pain after anæsthetization is less marked; (5) no ice-crust forms on the frozen spot; (6) the thermo-cautery can be used with ease in bromide-of-ethyl spray.

The tissues become frozen after two to three minutes. By the thermometer, the temperature falls at the same time to 15°. Bromide of ethyl has a specific gravity of 1.40, boils at 40.7°C. (105 2°F.), is easy to prepare, and is very stable. Terrillon has used it in numerous cases with the best results."

In studying the medical literature of the time when cold of an intense degree was the only, or the chief local anæsthetic agent used, we find that something else was continually being sought for, and many substances were subjected to experiment with the hope that some one of the many tried would possess the power of suspending the nerve function in the part of the body to which the substance or combination of substances were applied. The study of these experiments, which were not attended with any great or striking results, at least,

*Philadelphia Medical Times, vol.. xi, p. 240.

in the finding of an ideal local anæsthetic, are productive of good as by so doing we are enabled to reach the end sought without having to travel in the same paths which have been previously followed, and obtaining the same results.

The following abstract contains information that will prove of much use, if not in obtaining an anæsthetic condition of sufficient degree for painless operations; by its use we can obtain freedom from pain in hyperæsthetic conditions of the surface.

Prof. Redier, (*Glasgow Medical Journal*) says: "It is often desirable to apply locally some anæsthetic material to deaden the sensibility sufficiently for small operations. There are various expedients proposed for this purpose. We do not refer to the use of ether spray, but to various liquids which may be applied, and the sense of pain so far obtunded as to permit incisions without experiencing any other sensation than the mere touch. The mixture of chloral and camphor are triturated together, a clear, somewhat viscid, transparent solution results. This solution has considerable solvent power, and will take up a comparatively large proportion of morphia. Chloroform may also be added to it without precipitation of any portion of the dissolved constituents. Thus:—Chloral; camphor; of each ℥ij; morphiæ sulph., ℥ss; chloroformi, ℥j.—M. This may be applied with a camel's hair brush over the area to be incised, allowed to dry, and reapplied as freely as may be necessary to render the part insensible to pain.

Amongst the anæsthetic mixtures for surgical purposes proposed by Prof. Redier, are solutions of camphor in ether and in chloroform. According to Redier, one drachm of camphor may be dissolved in two drachms of ether, or the same quantity of camphor in two drachms of chloroform. A useful anæsthetic mixture is prepared by the addition of crystallized acetic acid to chloroform, in the proportion of one part of the acid to twenty parts of chloroform. These anæsthetic solutions are applied by the brush freely over the part the seat of pain, or to be incised. In some instances it may be better to moisten a cloth or some cotton and allow it to remain for some time in contact with the part."*

The following case which was reported by Guérin, *Medical Press and Circular*, shows the effect had by the use of † Vienna paste.

"M. Jules Guérin read a note at the Académie des Sciences upon a method of rendering the skin insensible in those operations which do not admit of chloroform by inhalation, and cited a case in which he had employed it to advantage. A lady, æt. 60, consulted him three months ago for a tumour in the right breast of eight years' standing, which, on examination, proved to be a schirrhus. The general health was bad, bronchial and cardiac troubles were very manifest, and the kidneys were not in a very satisfactory condition. However, the operation was urgent. Chloroform having been

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*Braithwaite's Retrospect, Part, lxxxviii, p. 280.

† Potassa cum calce made up into a paste with a little alcohol.

considered dangerous, M. Guérin applied around the tumour a circular layer of Vienna paste, limited by a double band of diachylon. At the end of twenty minutes the caustic was removed, leaving in its trace a black ribbon-like line. The knife was then applied, and the tumour removed without the patient feeling the slightest pain, and she did not seem to be aware of the operation. The results were all that could be desired."*

For inducing an anæsthetic condition of mucous membranes, menthol does excellent service, and at the same time does no injury to the part to which it is applied.

"Dr. Albert Rosenberg,† of Berlin, has found menthol, in etherial or alcoholic solution, (20 to 30 per cent,) a useful preparation in cases where local anæsthesia of mucous membranes—e.g., of nose, pharynx, and larynx—is required. The effect of menthol is not lasting, but appears to have somewhat of a cumulative action; for when repeated, even after a long interval, the latter application produced a longer period of anæsthesia than the earlier.

One of the most useful local anæsthetics for application to the mucous membrane of the mouth is prepared as follows:—℞. Tinct. aconite, alcohol, chloroform, equal parts of each, mix. Apply by moistening a pledget of cotton and holding against the part. This mixture will destroy nearly all sensibility of the gums, making it valuable in cases of tooth extraction.

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* Braithwaite's Retrospect, Part, lxxxviii, p. 280.

† Braithwaite's Retrospect, Part, xcii, p. 245.

We would also call attention to the following useful preparation. ℞. Camphor pulv., ʒvj ; Ether sulph., ʒj. Mix. Apply this to the gum surrounding the tooth to be removed, until the gum turns white, when the tooth can be extracted with scarcely any pain.

Thus far in this work we have considered only those means or agents which could be, or were only applied externally for the purpose of destroying sensibility in the part to which such application was made ; by some these agents are now considered to be obsolete, but, such is not true ; we of today possess agents for inducing local anæsthesia which are of a wider range of application than those used by surgeons formerly ; but some of the means then employed will prove of as much value as those more recently devised.

The principal agent, of which we give a short history, in use today for securing an anæsthetic condition locally is cocaine, a drug derived from *Erythroxylon Coca*, which shrub or plant is indigenous to the mountains of Peru and Bolivia. Although cultivated in other countries to some extent, the coca-leaves cultivated elsewhere are considered inferior to those of South America. It reaches a height of from six to nine feet ; the leaves which are the only part of the plant used are of the following description : alternate 3-4 to 2 or 2 3-4 inches long, 1 to 1 1-2 inches broad, ovate, lanceolate or obvate-oblong, rather obtuse, and frequently emarginate, somewhat narrowed into the short petiole, entire on the margin, rather thin, smooth, the lower surface pale

bluish-green, reticulate on both sides, with a prominent midrib, on each side of which is a curved line running from the base to the apex, which is due to strands of collenchyme cells. The leaves have a slight but agreeable odor, similar to that of tea, and a somewhat astringent bitter, and a pleasant aromatic taste.

The plant begins to yield when it is about a year and a half old, and the leaf should be gathered in dry weather.

We are unable to find anything definite in regard to the first use of coca, other than that it was used by the aborigines of South America long before their conquest by the Spaniards.

Joseph Acosta says in a print published in 1653: "The indians esteem it highly, and during the reign of the Incas, the common people were not allowed to use coca without the permission of the governer."

It is said that the disappearance of the empire of the Incas, far from diminishing the importance of coca, on the contrary gave a very much greater scope to its popularity. The natives profited by their freedom from the restrictions imposed by the native rulers in regard to the consumption of coca, and soon the use of the leaf became so common that it has been compared to the use of tobacco in this country.

Observation had of the parties using the coca leaf assured the observers that by the use of these leaves they were enabled to endure greater hardships, and longer deprivation of food than those who were not provided with the leaf.

"Unanué, of Lima, relates that at the siege of La Paz, Bolivia, in 1781, only those inhabitants who had taken coca were able to endure hunger and fatigue. Nearly all of the soldiers perished, deprived, as they were of food and overcome by forced marches, except those who had taken the precaution to provide themselves with coca leaves."

"The indians who accompanied me on my voyage," says Weddel, "chewed coca leaves all day, neither drinking, eating, nor showing any signs of fatigue. But at evening they replenished their stomachs like men who were completely famished, and I can assure you that I have sometimes seen them devour at one meal more aliment than I could have consumed in two days."

In this statement he accords with Bibra (1853) in stating that coca has the power of putting aside for some time the sense of hunger. Whilst, however, it may mask the appetite, it certainly does not nourish the body. Thomas Moreno y Maiz (1868) made several crucial experiments by keeping animals in pairs without food, and giving to one coca freely. These experiments were repeated by B. von Anrep (1880) and in every case the animal which received the coca died at least as early as its mate.

Observations similar to these were made by quite a number of observers, and then the desire to know the active principle led to a series of investigations by Gardeke, who in 1855 separated the alkaloid and gave it the name of *Erythroxyline*. In 1859 Niemann who had

been investigating the properties of the leaves obtained the active principle to which he gave the name of *Cocaine*.

Demarle gave his views on cocaine in the year 1862, pointing out certain properties attributed by him to the alkaloid that the leaves of the plant contained, and which he studied. He remarked, among other things, the dilatation of the pupils, which he had noticed in his own case after having taken a dose of coca; he also noted the absence of taste for a greater or less length of time after crushing some leaves with his teeth and letting them remain in the mouth.

Jules Auber, of Paris, claims that Dr. Schroeff in 1862 pointed out for the first time the anæsthetic and analgesic properties of cocaine, while other writers claim this honor for Demarle.

It is generally credited to Charles Fauvel as being the first to describe the anæsthetizing effect of coca on the pharyngeal mucous membrane; this was in the year 1877.

As we study the record of these experiments and observations which were being made with coca and the alkaloid cocaine by various physicians and chemists during these years; 1855 to 1884; we see how near they came to reaching the great discovery that was made known by Karl Köeller of Vienna, in the year 1884, when he pointed out the use of this drug as a local anæsthetic to the tissues of the eye.

In the year 1868 Moreno y Maiz went so far as to say that he had "employed it [acetate of cocaine] as a local anæsthetic. In 1874, Dr. Hughes Bennett pub-

lished his well-known experimental inquiry into the physiological action of theine, caffeine, guaranine, cocaine, and theobromine, and demonstrated that cocaine exerted its influence chiefly on the sensory nerves, and was anæsthetic. In 1876, Dr. Ott published a paper on cocaine, and showed that it dilated the pupil. Again in 1880, von Anrep called attention to the probable value of the alkaloid cocaine as a local anæsthetic.

All of the observations appear to have been forgotten, until Dr. Köeller demonstrated through his friend Dr. Brettauer of Trieste, at the Ophthalmological Congress at Heidelberg, the anæsthetic action of a solution of cocaine when applied to the mucous membrane of the eye.

It is said that Dr. Köeller had for some time been aware of the anæsthetic effect of the alkaloid cocaine when applied to the tongue, and this fact led him to believe that he might get similar results from its application to the eye. He made several experiments on the eyes of animals, from which he found that two or three drops of a two per cent. aqueous solution of chloride of cocaine, introduced into the conjunctival sac, rendered the cornea and conjunctiva quite insensible. If he scratched with a needle, or even perforated the cornea of animals so treated, or passed a strong electrical current through it, or touched it with caustic, the animals felt no irritation at all. As to the duration of this anæsthesia, he could obtain no idea from his experiments on animals.

"At the Heidelberg Clinic two drops of the solution were dropped into the eye of a patient experimentally, and in a few minutes it was noticed that the sensitiveness of the surface was below the normal. A drop or two more and the anæsthesia was complete; a probe was pressed upon the cornea until its surface was indented, it was rubbed over the surface of the cornea, it was rubbed over the conjunctiva, a speculum was introduced and separated the lids, and they were stretched to their utmost, the conjunctiva was seized with a pair of forceps, and the globe was moved about in various directions, but there was no pain, and the patient declared that he experienced no inconvenience of any kind. Before the experiment the eye had been tested, and was shown to possess the normal sensitiveness; the other eye, which was not treated, remained in this respect perfectly normal. At first a 2 per cent. solution was used, but subsequently it was increased to 4 per cent."

From the experiments conducted by Dr. Köeller, it was learned that: (1) One or two minutes after introducing a few drops of a two per cent. solution of cocaine chloride the cornea and conjunctiva were rendered completely insensible. The anæsthesia lasted from seven to ten minutes, and disappeared gradually. (2) Simultaneously with the anæsthesia, considerable dilatation of the palpebral orifice occurred, which he explained by the absence of the sources of irritation which otherwise affect the cornea and conjunctiva. (3) The ocular and palpebral conjunctiva became anæmic. (4)

Fifteen minutes after introduction, mydriasis set in. It was never present in any great degree; after an hour it decreased considerably, and totally disappeared some hours later. During this period the pupil re-acted quickly. (5) Paresis of accommodation set in together with the mydriasis, and also disappeared with it. (6) When the application of the above-mentioned solution of cocaine chloride was continued, and repeated every five minutes, the anæsthesia of the cornea lasted from fifteen to twenty minutes, and the deeper parts of the eyeball became anæsthetic, its sensibility being much diminished on pressure. (7) The application of cocaine never produced any signs of irritation. He obtained good results with it in various diseases of the cornea and conjunctiva, which were associated with pain and photophobia, as, *e. g.*, syndesmitis lymphatica and erosions of the cornea; it was also of use in cases in which the touching of the eyelids with nitrate of silver would cause severe pain. He recommended the application of cocaine in cases of iritis and irido-cyclitis where the contraction of the vessels must render good service. The application of cocaine as an anæsthetic in ophthalmic operations had excellent results in thirty cases of removal of foreign bodies from the cornea, in cases of tattooing cicatrices on the cornea, in two cases of operation for staphyloma in children, as well as in several iridectomies and operations for cataract. When the anæsthesia in these operations was produced according as he recommended, *i. e.*, with a five per

cent. solution, the patients stated that they felt nothing of the corneo-scleral incision, while the seizing and excision of the iris caused them but little pain."

It is somewhat amusing to read the opinions given by some, as to how cocaine acts as a local anæsthetic. When injected hypodermically, they claim that the effect is obtained by the injection distending the part, putting the nerves on a stretch, and in that way suspending the function of the sensory nerves. This will not explain its action on mucous membranes, neither does it explain why we get toxic symptoms from its use.

"The most susceptible portion of the body to the action of the alkaloid cocaine is the cerebrum. The peculiar sense of calm, which follows moderate doses of the drug, is evidently the result of the action on the brain, which eventuates, after a sufficient dose, in the peculiar ecstacy called 'cocaleine intoxication.' The movements are not at all those of convulsions, but are voluntary and accompanied by every expression of joy and exhilaration; this condition may continue for hours, then become gradually quiet, and pass finally, into the normal condition."

"According to the researches of von Anrep, the convulsive movements are of cerebral origin, and are arrested by section of the spinal cord. Dannini appears, however, to have found that the section of the cord did not prevent convulsions in the hind feet. To settle this discrepancy further experiments are of course necessary. It is to be remarked that even von Anrep af-

firms that after, as before, section of the spinal cord, reflex activity is increased by cocaine, and certainly other observers have noticed an increased reflex activity as constant after small doses. This evidence indicates that the drug stimulates the motor tract of the spinal cord; yet it is possible that the sensory stimulation may be the sole cause of the excited reflex action.

It is established, by the concord of almost all observers, that the sensitive nerves, after sufficient doses of cocaine, are finally paralyzed, and the statements and experiments of Nikolsky, of B. von Anrep, and also of Ott, appear to prove that the stage of sensory paralysis is preceeded by one of increased functional activity of the afferent or sensory nerves.

The motor nerves, according to Dannini, in the frog remain irritable until after death; but according to Nikolsky their functional activity is first increased and afterwards destroyed. Ott also asserts that cocaine depresses the motor nerves, and Moreno y Maiz found that when he tied the iliac artery of a frog on one side and administered cocaine anteriorly, there came a time when irritation of the poisoned limb caused no movement, whilst irritation of the protected extremity provoked very distinct reflexes; at the same time there was diminished motility in the non-protected limb as compared with the protected one. These facts, of course, indicate that the drug finally depresses both motor and sensory fibers, but that its action upon the motor is subordinate to that upon the sensory nerves. Ott al-

so noticed that there is a time in the poisoning when irritation of the central end of a cut sciatic nerve produces no response, whilst irritation of its peripheral end causes muscular action, and thereby confirms the view that the drug affects the sensory earlier and more powerfully than the motor nerves."

"Laborde, who has already published the results of studies made as to the physiological action of cocaine, has continued his investigations and obtained some very valuable and interesting conclusions. The experiments were made with the neutral sulphate of cocaine in a one per cent. solution. He has found that injection of one centigramme of the salt under the skin of the back of the guinea-pig produces the most exaggerated movements in the animal, which, strangely enough, are accompanied by anæsthesia, most emphasized in the posterior extremities. If after a few minutes, the dose is repeated, the movements become wild and violent, as already described by von Anrep, while the anæsthesia is present over the entire skin, even of the mucous membrane of the nose, although apparently the conjunctiva retains its sensibility, and the pupils are dilated; convulsions soon appear, both tonic and clonic, contractions of the anterior extremities and of the muscles of the eye, evacuations of greenish fæcal matter, frequent urination, passing into a condition of tonic opisthotonos. After lasting for a variable time this condition may disappear, to again recur, until finally the animal appears entirely paralyzed, although again to be convulsed, and finally to

completely recover, although the insensibility of the skin may last for forty-eight hours after the injection. In the guinea-pig the same appearances are observed after the administration of cocaine, but in the dog the excito-motor symptoms appear less intensified than the paralysis of sensibility, although here also their intelligence remains unchanged, and all the mucous membranes, with the exception of the conjunctiva, are anæsthetic.

After toxic, but not fatal, doses the circulation and respiration are very irregularly affected; when a poisonous dose is given at first the respiration is slowed, and then accelerated, finally becoming irregular, frequent, and intermittent, and in the last stage of the poisoning the respiration is again greatly accelerated and deep, and the animal dies in convulsions from asphyxia, while the heart may still beat regularly, though feebly for one or two minutes longer. During the action of cocaine the blood-pressure may be considerably increased, while the heart-movements are slowed from increased irritability of the pneumo-gastric. During the convulsions the temperature rises, but when asphyxia appears it rapidly falls; the salivary secretion is increased, and the urinary secretion is diminished. Laborde places the fatal dose of cocaine at 11 milligrammes per kilo. of body weight.

The seemingly paradoxical statement that the same drug can produce simultaneously an increase of functional activity of the motor and a paralysis of the sensi-

tive nerves actually appears less strange when one remembers that in nearly all pathological conditions abnormal increase of functional activity or paralysis are phenomena which are frequently closely allied, and which may easily pass from one condition to another; thus, a condition of hyperæsthesia frequently passes into anæsthesia, and contracture is often a preliminary stage of paralysis.

Cocaine produces its motor effects from its direct action on the central and peripheral excito-motor elements of the system. That the medulla and spinal cord are included in this action is proven by the character of the convulsions, while the influence of cocaine on the peripheral nerves has been shown by Laborde in the case of the sciatic and vagus nerves. Further than this, the remarkable and apparently voluntary character of the movements prove that the psycho-motor centre is also implicated in the poisoning. As regards the paralysis of sensation produced by cocaine after subcutaneous or internal administration, Laborde attributes the anæsthesia to the dulling of the preceptive faculties of the cerebrum, since centripetal condition in the sensitive nerves is not interfered with (though Laborde differs as to this point with most other observers), and all reflexes are perfectly preserved, even in the most profound stage of cocaine anæsthesia, although such reflexes, when of a violent character, are entirely free from all painful sensations. A different state of affairs, however, occurs when the cocaine is applied locally; here

the depressing action on the nerves and muscular elements produced by imbibition of the poison are much more marked, and although the sympathetic nerve is included in this paralysis, all attempts have yet failed to decide the question as to whether the muscular and vascular systems are also affected.

Laborde further draws attention to the interesting contrast in the action of cocaine and curare, and believes that an actual antagonism will be found between these two poisons. Cocaine has as yet, as far as we know, been used solely for its anæsthetic action, but these results of Laborde would seem to warrant its employment for the directly opposite purpose of availing ourselves of its excito-motor action. It would seem that the physiological action of cocaine, as determined by Laborde, would indicate its employment in all cases of chronic weakness of the nervous system, especially in prolonged convalescence, in atrophies, and in nearly all cases of functional paralysis.

As is well known, when cocaine is injected subcutaneously the temperature of the body falls; as to whether this reduction of temperature is due to a decrease in the heat-dissipation or to an increase in the heat-production has recently been experimentally determined by Richet.* He found that not only the heat-dissipation, so far from being diminished, was actually increased, but that the heat-production and chemical changes occurring in the tissues were much more active than in normal condi-

* Centralblatt f. klin. Med., April 11, 1885.

tions ; as a consequence, therefore, animals under the influence of cocaine will lose weight. For we not only have increased oxidation processes in the body, but we have also increased removal of the heat, the principal result of those processes.

Recent investigation has made it probable that the dermal sensations of heat, cold, pressure, and pain are all conducted to the cerebrum by special nerves. This being the case, it would not seem improbable that we might in some way abolish certain of these sensations from a given locality, while leaving the others intact, and in point of fact Mr. Donaldson* has found that the sensations of pressure and pain could be abolished from the conjunctiva by means of the muriate of cocaine, while those of temperature remain. He has found that when the eye was completely insensitive to pain the pressure of a small metal point cooled or heated in water (the temperature being 10° C. for the cold and 40° for the warm), and rested on the conjunctiva, the hot and cold metal could in all cases be readily distinguished. Thus far attempts to get the same result from the skin have been made in vain, and the results obtained by Mr. Donaldson in the case of the conjunctiva are directly contradicted for the skin in the experience of Dr. Henry B. Millard.† He found that when the skin was painted thickly with several coats of the four per cent. solution of Merck's cocaine, coldness and numbness of the skin

* Maryland Medical Journal, April 1, 1885.

† New York Medical Journal, May 2, 1885.

were produced, and that the application of the Paquelin thermo-cautery apparatus was entirely painless, although, of course, followed by burning, and he reports several cases confirmatory of this statement.

M. Arloing has also made an extensive series of researches on the physiological action of cocaine, which led him to the following conclusions (*British Medical Journal*, April 25, 1885) :

"Hydrochlorate of cocaine is a purely local anæsthetic, and contact of the terminal nerve-plates with cocaine is the principal cause of anæsthesia. Cocaine provokes constriction of the capillary blood-vessels ; but M. Arloing does not think the corneal insensibility produced by cocaine ought to be attributed to regional anæmia, inasmuch as anæsthesia can be produced before and after section of the cervical branch of the sympathetic nerve. The anæsthetic effects of salts of cocaine are very evident on epithelial mucous membranes, on one especially in which the nerve is intra-epithelial, that of the cornea. Thus it may be argued that anæsthesia from cocaine depends on contact, and this is not impeded by the local circulation. In the nerves, where the nerve-elements are protected by the peripheral connective tissue and the lamellar sheath, anæsthesia is more slowly produced. Interstitial injections of cocaine anæsthetize small nerves, as has been proved in the enucleation of the eyeball. A solution of cocaine deposited on the surface of the eyeball of the guinea-pig slowly penetrates through the epithelium ; the nerve-terminations

are impregnated. It traverses the cornea, circulates among the lymph-canals and aqueous humor, bathes the iris, and finally passes into the circulatory system, and kills the animal. M. Arloing concludes that cocaine-salts temporarily modify the physical properties of protoplasm, the elements of nerve-terminations, and the fibrillar elements. On the other hand, Dr. Brown-Séquard believes that the anæsthetic effect of cocaine is due to inhibitory phenomena. In a communication to the Biological Society, he stated that the fact that wounds become anæsthetized when the animal's larynx is irritated by carbonic acid, chloroform, or galvanization, suggested to him that the action of cocaine is inhibitory. Dr. Brown-Séquard observed that, by slightly stimulating his laryngeal mucous membrane, he relieved a feeling of intense fatigue, and also removed rheumatic pains. He injected hydrochlorate of cocaine along the superior laryngeal nerve of an animal. All the wounds inflicted were anæsthetized, and the sciatic nerve was stretched without producing the slightest pain; an analgesic zone existed around each wound. All the wounds inflicted after the application of cocaine were in a state of hyperalgesia. Dr. Brown-Séquard therefore refuses to admit the anæsthetic effect of cocaine, and further asserts that, if a large dose be injected, the poisonous properties of cocaine prevent the anæsthetic phenomena."*

"Dr. M. Bresgen, †(*Deutsche Med. Wochenschrift*,

* Therapeutic Gazette, June 1885. p. 386.

† London Medical Record, Feb. 1886. p. 52.

No. 46, 1885), points out that the anæsthetic effects of cocaine on mucous membranes undergo many modifications in individual cases. Moreover, in the same person the same local effects do not always and invariably take place, notwithstanding that the identical preparation and method have been employed. Idiosyncrasies and dispositions play a prominent part. The same may be the case with the symptoms of internal poisoning, when, what undoubtedly is most important, cocaine has been introduced into the stomach.

When bringing the nose and the throat under the action of cocaine, also when employing solutions of 10 per cent. and 20 per cent. of Merck's preparation, the soluble hydrochlorate of cocaine, Bresgen frequently had occasion of observing moderate and rapidly passing symptons of poisoning, viz., sensation of coldness and abnormal paleness over the whole body, and slight giddiness. The conditions described by the patients as nausea and inclination to vomit, appear not to be due to the poisoning, but to the anæsthesia of the fauces. There is a sensation as if something ought to be ejected, but all the efforts of doing so remaining resultless, only the movements of retching are produced. Actual vomiting, even in the cases of severe poisoning after cocainising the nose, of which anon, never came under Dr. Bresgen's notice."

We desire to call attention to the following which we take from (*Therapeutic Gazette*, June 1892, p. 405), as an explanation of how cocaine causes death

or gives rise to toxic symptoms of an alarming nature.

"Maurel (*Bull. Gén. de Thérap.*, March 15, 1892) has published an interesting experimental study of the action of cocaine upon the blood of man and that of the rabbit. Among the many conclusions arrived at by the author, the following may be mentioned: 1. Death by cocaine appears to result from the destruction of the leucocytes, or from the changes produced in them through the influence of the drug. 2. Death appears to take place in two manners,—by *saturation of the blood* or by *embolism*,—according as the cocaine comes in contact with the blood in *non-toxic* or *toxic* quantities for the leucocytes. 3. In the rabbit, 1 centigramme of chlorhydrate of cocaine is sufficient to kill the leucocytes in one gramme of blood, and 1 centigramme of the salt per kilogramme of the body-weight, injected into the femoral vein of the animal, is likewise sufficient to produce death in less than five minutes. 4. Hypodermically administered, or by the stomach, the lethal dose is three times as large. 5. In man, the leucocytes in one gramme of blood die under a dose of from 1 to 1½ milligrammes; the same effect is produced in sixty grammes of blood, which is the tenth part of the whole amount in a man weighing sixty kilogrammes, by a dose of from 6 to 9 centigrammes of the salt. 6. In the rabbit, the rapidly toxic solutions for the leucocytes are in the proportion of from 75 centigrammes to 1 gramme per 100. 7. In man, the rapidly toxic solutions for the leucocytes range from 10 to 20 centigrammes per 100 of blood, the

average being 15 centigrammes. 8. The possibility, on the one hand, of killing a rabbit by an injection of cocaine sufficiently large to destroy the leucocytes in one-tenth of the animal's total amount of blood, and, on the other, the possibility of injecting the same proportionate amount of drug, in the case of man, may give rise to the assumption that such quantities produce the poisonous effects observed by being introduced directly into the blood. 9. In death by saturation, in the case of the rabbit, as well as that of man, the great tendency of the leucocytes is to assume the spherical form. 10. In death produced by intravenous injections, the fatal issue is caused through the rapid death of the leucocytes, which, assuming the form of rigid disks, act as *emboli*. 11. As stated before, death by cocaine is effected through two mechanisms,—*saturation of the blood* and *embolism*. 12. From the results of the experiments upon the rabbit, the solutions of the strength of 10 centigrammes of the chlorhydrate of cocaine per 100 grammes of distilled water are seven to eight times inferior to those which are lethal to the leucocytes; but they are sufficient to produce, injected into the cellular tissue, an anæsthetic effect, lasting about fifteen minutes. 13. In all cases, for hypodermic use, solutions higher than 15 centigrammes of chlorhydrate of cocaine per 100 grammes of distilled water, should not be employed. Feeble solutions are free from danger; those composed of 5 centigrammes per 100 grammes of water may be employed

in relatively large quantities without producing untoward effects.

The practical inference drawn by the author from this research is, that the danger of hypodermic injections of the chlorhydrate of cocaine, lies from the start in the concentration of the solution employed, and not in the quantity of the drug administered; and afterwards, in the accidental penetration of the toxic solutions into the blood-vessels."

From the foregoing may be learned the physiological action of cocaine. As to the results from its use in hands of various observers we submit the following, not as a complete review of the cases to be found in medical literature, but to a number of them which, show the great range of usefulness of the drug in question as a local anæsthetic.

In a study of the following cases, we ask the attention of the reader to the amount of, also to the manner of using the solution in all the cases here reported, and especially in those cases where toxic symptoms were shown.

The first case* to which we would invite your attention is one of an amputation of the thigh, in which cocaine was used, because of the alarming symptoms caused by ether. The patient, aged 39, of intemperate habits. Compound fracture of leg; all efforts through a period of five weeks, to save the limb proved useless, amputation was decided upon, and because of the ill ef-

* New York Medical Journal, vol. xliii, p. 210.

fects of ether, the operation was not performed until one week later, when anæsthesia was induced by a one per cent. solution being used for the skin, and a one half per cent. solution for the deeper tissues. The patient complained loudly at the slightest touch, especially was this so while the application of Esmarch's bandage was being made. After the first puncture, and all through the subsequent procedure, when his attention was diverted he made little complaint.

"The operation by antero-posterior flaps was the one chosen, cutting from without inward for the anterior, then transfixing the limb and making the posterior flap by cutting from within outward.

1. The first incision through the integument — no pain.

2. The second incision through the deeper tissues to the bone — no pain.

3. Transfixion of the limb — no pain.

4. No pain until near the completion of the wound, which was occasioned by carrying the knife beyond the line marked on the integument.

5. On carrying the knife around the bone to divide a few remaining attachments, there were some manifestations of pain.

6. The use of the saw occasioned loud complaints, although the subsequent removal of a spiculum with the bone-forceps was not noticed.

7. There appearing some redundancy of flap, the

scissors were used for the purpose of trimming. This procedure was absolutely painless.

8. The insertion of sutures was unnoticed except at the angles of the wound.

After the ligation of the vessels, which was painless, hot water slightly below the boiling-point was applied to the abraded surface, with no expression of pain."

The following cases of amputation of fingers were reported by Prof. Alexander B. Mott, at Bellevue Hospital Medical College.*

"The hand was bandaged tightly at the wrist so as to stop the circulation, and six hypodermics of a four-per-cent. solution of muriate of cocaine were made along the proposed line of incision and one deep down into the joint. About fifty-five minims were used in all. After waiting ten minutes the bandage was removed and the finger was amputated at the metacarpo-phalangeal articulation. The patient said that he *felt absolutely* no pain. The ligation of the blood-vessels, all of which were very much enlarged, took some little time, but during the entire period no complaint was made.

In the second case, the success was not so great, owing in a great measure to the fact that no bandage was applied to arrest the circulation in the part. Injections were made as before along the proposed line of incision around the metacarpo-phalangeal joint. No struggles were made by the patient while the finger was being removed, although she said that "it hurt," but on

* The American Practitioner and News, Feb. 6, 1886. p. 83.

being questioned afterward, admitted that it did not pain her as much as the introduction of the hypodermic needle, and that the soreness half an hour after the operation was greater than the pain experienced during its performance. In this case about forty minims of the solution were administered. In using the muriate of cocaine in similar operations in the the future, I shall most assuredly apply an Esmarch's bandage, so as to limit the action of the cocaine to the part that is to be operated on; and I have no doubt that, by pursuing this plan and injecting the solution not only hypodermically but deep down on to the sensory nerves themselves, far more formidable amputations could be accomplished with almost absolute painlessness."

Dr. E. C. Rhodes (*Occidental Medical Times*, Mar. 1891)* reports a case in which he performed amputation through the wrist, using cocaine as an anæsthetic. The patient was a laborer in a mill, whose right hand had been crushed in attempting to couple two loaded cars. Chloroform was first given from a paper cone containing absorbent lint, on which was poured about a drachm of the anæsthetic, the cone being about one inch from the face, so as to give the patient plenty of air. After two or three inhalations respiration stopped, while the pulse remained good. Three attempts were made to bring the man under the influence of chloroform, each time with the same resnlt. Ether not being at hand, it was determined to try cocaine. A 20-minim

*Supplement to the British Medical Journal, June 27, 1891, p. 202.

hypodermic syringe having been filled with a 5 per cent. solution, 5 minims were injected into the dorsal and 5 into the palmar surface of the wrist. No bandage, compress, or tourniquet was used above. After five minutes the injections were repeated in the same doses and almost in the same spots. Dr. Rhodes then immediately began the operation without professional assistance. The patient reclined in a chair, looking away and talking throughout the operation; he did not complain of pain except during division of the deep tissues on the palmar side of the wrist. When the amputation was completed a 10 per cent. solution of cocaine was applied to the open wound for about two minutes before it was closed. The patient arose from the chair, expressed himself as feeling very much better, walked out of the office, got into the buggy, rode 2 1-2 miles to the mill, ate a good big dinner, and never kept his bed a day nor missed a meal from the effects of the operation."

The following case was reported by G. Michelmore, (*Lancet*, Oct. 29, 1887):

"Emma V. required the removal of a finger at the terminal phalangeal joint on account of a bad crush. The finger was painted over with a 20 per cent. solution of the hydrochlorate of cocaine, and ten minims of the same deeply injected. No pain was felt during the operation."

"Patient aged 78, *Medical Record*, 1887, the case being one in which amputation of the breast was re-

quired. The operation was performed without any pain by means of local anæsthesia; the anæsthetic was confined to the region of operation by the use of a large rubber ring as devised by Dr. Corning. A two per cent. solution of cocaine was then injected into the skin along the entire line of incision. Then the base of the tumor was flooded with the same solution. The operation was painless and exceedingly satisfactory. Only three drachms of this two per cent. solution were used, the operation lasting twenty-five minutes."

Our experience in the use of cocaine as a local anæsthetic has been limited, but it has in every instance proved itself to be one of the most valuable aids in surgical work, of which we have knowledge; by its use we have been able to perform operations that without assistance would have been impossible.

The following case may be of interest. Patient, aged 22, at work in a saw-mill, one of the night shift, right hand came in contact with a saw which cut off all of the fingers near the first joint, leaving the stumps in such shape that it was necessary to amputate a portion of each one, it being in the night time and having no proper assistance I made use of a solution of cocaine of one-half a grain to one drachm of water, about one-half this amount was used during the operation, first placed an Esmarch's bandage on the wrist to prevent hemorrhage, then injected a few drops of the solution into each finger in several places on both the dorsal and palmar surfaces, after this the operation was proceeded with, the patient

making no complaint when his attention was drawn away, he not being concious of pain unless he was watching the work, even the cutting of the bone giving no pain. The fingers healing without any pus formation.

In another case of injury of the hand requiring amputation, I was able to dress the hand without assistance: Patient aged 38, was at work in a saw-mill, his hand, which came in contact with a bench-saw, was badly lacerated. It was necessary to amputate three of the fingers, and to suture all of the tendons on the dorsal surface of the hand. Not having any suitable assistant, I used a solution of cocaine of the same strength as used in the previous case, and with equally good results.

"Mr. C. E. Jennings (*Lancet*, 1865, p. 663),* records two cases in which he used cocaine to alleviate pain, whilst caustics were applied to cancerous growths. One patient was aged 73, and suffered from extensive scirrhous ulceration of the right breast. The surface of the ulcer was covered with rugged irregular granulations which bled upon pressure; the veins around the growth were much engorged, and the pain was increasing. After painting the ulcerated surface with a ten per cent. solution of hydrochlorate of cocaine, a paste was applied consisting of cocaine, potassa fusa, and vaseline. After some minutes a burning sensation was experienced; then the paste was quickly removed with

* London Medical Record, Dec. 1885. p. 516.

the charred tissue, by means of pledgets of cotton-wool previously moistened with water. The denuded surface was again painted with cocaine solution, and the compound paste reapplied. By this means, more than a tablespoonful of cancerous growth was removed by a rapid and painless process. The next day a clean, smooth, and bloodless surface, insensitive to the touch, was presented. By this means, most of the schirrhous mass was removed after a few applications. In the second case, the author destroyed a cancerous growth of the os and cervix uteri, by means of sticks of potassa fusa, and a ten per cent. solution of cocaine."

"Dr. O. Pritchard, (*Lancet*, Dec. 1884, p. 1167,)* reports a case of circumcision on a patient aged 23, and, having explained to him the action of cocaine, he resolved to give the drug a trial. A 4 per cent. solution of the hydrochlorate of cocaine was made in distilled water, and 4 minims of it were injected through the foreskin at four different points. In about twelve minutes anæsthesia was complete all around; the operation was then performed, the patient watching the proceedings with considerable interest, and feeling no pain at all. The local effects lasted long enough for the man to walk home and to go to sleep without feeling any pain."

"Dr. Lewis Schooler, (*Therapeutic Gazette*, 1886, p. 488), reports a case of circumcision, which might be very properly termed a mixed case, as the solution was painted on the mucous surface, and also injected hypo-

* London Medical Record, Feb. 1885, p. 68.

dermically between the integument and the mucous membrane in the following manner: After painting the mucous surface thoroughly with a four per cent. solution of cocaine, the prepuce was drawn forward and grasped with forceps in the hands of an assistant, when forty drops of the same solution were injected beneath the integument in four different places. After ten minutes the operation was performed in the usual manner, without any pain whatever."

"Mr. Mago Robson, (Brit. Med. Jour., Nov. 1886, p. 859,)* records a case in which cocaine proved an excellent anæsthetic. A middle aged man was operated on for epithelioma of the tongue. The solution used was one grain of cocaine in ten drops of water, this was thrown into the tongue deeply and back of the tumor. After a wait of ten minutes the growth together with a portion of the tongue was removed by the écraseur. The part was removed without difficulty and without pain."

"Dr. J. A. P. Price records a case (*Brit. Med. Jour.*, Aug. 1885, p. 396,) in which he removed a small epitheliomatous growth from the lip of a man aged 60. The author injected about one-sixth of a grain of cocaine into the substance of the lip, and painted the mucous membrane in the neighbourhood of the sore with a 5 per cent. solution of the drug. After waiting about six minutes the growth was quickly removed and sutures inserted. The patient stated that he felt the skin being cut and the needles inserted, but the pain was not very

* London Medical Record, Dec. 1886, p. 535.

sharp. Half an hour after the completion of the operation the patient complained of a burning sensation in the wound, thus showing that the effect of the drug was passing away."

"Dr. L. Schooler, (*Therapeutic Gazette*, '86, p. 488), reports a case of ulcerating epithelioma on the dorsal surface of the hand of a gentleman aged 70. An Esmarch bandage was applied from the tips of the fingers to a point midway between the wrist and the elbow, where several turns of the bandage were made around the arm and left *in situ*, while that portion enveloping the fingers and hand was removed, and the tumor, which was circular and one and one-fourth inches in breadth, was freely injected at the base with a four per cent. solution of cocaine, and, after the lapse of twelve minutes, was removed with the scalpel, and the edges brought together with no pain whatever, except as the last suture was being put in; the patient sitting on a chair, observing the operation and feeling perfectly comfortable, as he himself expressed it."

"Dr. de Coninck, of Ledeberg-les-Gant, writes to the *Scalpel*, of Liège (*Le Moniteur du Practicien*, Jan. 15),* that the effects of hydrochlorate of cocaine in facial neuralgia, and in cephalgia having its seat in the temporal region, are surprising. The pain, be it ever so intense, will instantaneously cease on applying to the auditory canal one minim of a solution of 1 per cent. of this salt, by means of a small camel-hair brush. This sig-

* London Medical Record. 1886, p. 107.

nal effect, however, will only continue for a few hours, after which a repeated application may be required. Hydrochlorate of cocaine has never failed in the many cases of these kinds of neuralgia, treated in that manner by Dr. de Coninck. In neuralgia of the fifth nerve and its branches, however, the results were less certain and less satisfactory, owing, perhaps, to the superficial mode of its employment."

"Dr. W. S. Paget, (*Brit. Med. Jour.*, July 1886, p. 18.)* states that he can testify from personal experience to the efficacy of cocaine in hay fever. He employs a two per cent. solution and with an atomizer he sprays a few minims upon the eyes, with the lids half closed, and afterward each nostril, this gives relief for some time; with a return of the symptoms, the spraying should be repeated. About one-half grain is sufficient for one spraying."

"Dr. Frank P. Hudnut, of Brooklyn, reports (*Medical Record*, Oct. 20, 1888), a case of single harelip in which cocaine was the anæsthetic: Boy aged nine years, of healthy parents, had a well-marked case of harelip on the right side, with cleft palate. He was unable to hold water in his mouth after the glass had been removed from the lips. After fastening two clamps on the lip to cut off as much of the circulation as possible, I injected, in four places along the lines for incision, fifteen minims of a four per cent. solution of cocaine. After waiting three minutes I proceeded with the operation. The

* London Medical Record, 1886, p. 347.

child never cried or appeared to suffer until I was introducing the last two stitches. The operation was a complete success in every way. The stitches were removed on the third day."

There is much to be found in the current medical literature in regard to the use of solutions of cocaine in the operation for the cure of hydrocele. The operation being performed in the usual manner, first removing the contents of the sac; then by the introduction of a solution of cocaine destroy the sensibility of the part previous to the injection of the tincture of iodine, or other agent used for the purpose of changing the condition of the membrane, or obliteration of the sac. In some of the cases reported disagreeable effects were had, which was thought to have resulted wholly from the use of the cocaine solution. The solution varied in strength from five to twenty-five per cent. and the amount injected also varied greatly; from drops to drachms. The symptoms which generally manifested themselves were pallor, restlessness, and prostration; when it is remembered that we do sometimes get all of these symptoms in some of these cases where no drug has been used, it would seem a little irrational to attribute all of the ill feelings of the patient to the use of the cocaine. We have not found any case of hydrocele in which death was caused by the use of the cocaine solution used in this way, although several are reported in which alarming symptoms manifested themselves.

"In the *Brit. Med. Jour.*, Nov. 1884, p. 1074, Dr.

Prosser James writes that he has used a weak solution of the hydrochlorate of cocaine with great success in cases of intralaryngeal operations. A solution of 2 to 4 per cent. painted over a mucous membrane once, twice, or thrice, at intervals of three to five minutes, produces local anæsthesia, lasting from a quarter to half an hour, and that without exciting any irritation whatever. It is extremely useful also in cases of extreme irritability of the fauces in phthisis and other diseases."

"Professor N. P. Simanovsky, of St. Petersburg, eulogises (*Vratch*, 1885, No. 21)* the value of cocaine in cases of excision of laryngeal polypus. In six operations recently performed by the author, in two no cocaine was employed, and the preparation of the patients for the operation had required about two months; while in the remaining four cases, cocainisation of the parts allowed the immediate performance of the excision."

"In the *Philadelphia Medical News*, July 1885, Dr. Porcher relates the case of a lady who had her toe-nail removed after applying cocaine locally. A 4 per cent. solution of the hydrochlorate was dropped upon the raw surfaces in the furrows on each side of the nail. A rag soaked in the solution was pressed against the upper surface of the toe, and three injections were made into the flesh at the base of the nail, just above the matrix. After an interval of fifteen minutes the toe-

* London Medical Record. No. 125, p. 484.

nail was removed in the usual way, without causing the slightest pain."

"In the *Khirurgitchesky Vestnik*, Aug. '86, p. 498,* Dr. T. J. Vdovikovsky, of Odessa, describes four cases of Bigelow's operation, where he, following the example of R. Weir, Bruns, Ceci, Caselli, Galozzi, Morell, Dubuc, &c., used local anæsthesia with cocaine. Having washed out the bladder with a 4 per cent. solution of boric acid, or a weak solution of corrosive sublimate he injected into the viscus 3 1-2 ounces of a 2 or 4 per cent. solution of hydrochlorate of cocaine, to commence the operation ten or fifteen minutes later. As the author's cases show, absence of pain is associated with an absolute absence of contractions of the bladder. The latter remains immobile during the whole period of action of the drug, thus enabling the surgeon to perform a thorough smashing of the stone, and the removal of the smallest splits and débris. Unfortunately, an average duration of the action of cocaine does not surpass thirty-five minutes, by the end of which time there again appear pain, and, ten or fifteen minutes later, also contractions of the bladder. Hence, cocainisation may be usefully employed only in those cases where there are present small stones, about 3 or 4 centimètres in diameter, which could be broken into pieces and removed in half an hour, the author advises to give chloroform, and — when strong contractions of the bladder are present, and interfere with, or mask, a thorough aspiration

* London Medical Record, No. 141, p. 99.

of fragments — to inject the cocaine solutions next the end of the operation. Dr. Vdovikovsky never saw any toxic effects of cocaine used as stated above. In conclusion, we may add that the author is one of the most enthusiastic advocates of Bigelow's operation in Russia. Of sixty-one patients operated upon by this eminent surgeon only *one* died."

"In a communication made to the *Société Médicale du IX Arrondissement*,* Dr. Dubuc described several cases in which he had employed cocaine in lithotrity. In the first case of a patient suffering from chronic cystitis and phosphatic stones, lithotrity was practised nine times in a year. Cocaine was first employed in solutions of 2 1-2 and 3 per cent. and finally in solutions of 4 and 5 per cent. About 30 grammes of the solution were injected into the bladder. The patient was made to assume various possitions in order that every part of the mucous membrane might be brought into contact with the solution. Each operation lasted from fifteen to eighteen minutes. The result of the cocaine was most satisfactory. In the case of a patient suffering from uric acid stones, with considerable epithelial desquamation of the bladder, a 5 per cent. solution of cocaine was twice employed. After the second time there remained only one fragment; the dry *débris* weighed 4 grammes 35 centigrammes. In cases where the bladder is perfectly healthy a 5 per cent. solution may prove insufficient. In a case of this description a 10 per cent.

* London Medical Record, No. 141, p. 102.

solution was first employed, with excellent anæsthetic results; 15 grammes and 10 grammes of the 10 per cent. solution was then administered. The anæsthetic results were less satisfactory. The author is therefore of opinion that 30 grammes of the solution chosen should be employed. The patient evinced no symptom of absorption of the cocaine. The last case described by Dr. Dubuc was that of a patient in whom the bladder was almost healthy; the urine was slightly turbid. Thirty-five grammes of a 15 per cent. solution, which represented 5 grammes 25 centigrammes of cocaine. At the end of six minutes the patient turned pale, and was inclined to vomit. The bladder was immediately emptied and washed with a solution of boric acid. Pulse regular, 72; the intelligence was intact. At the end of five or six minutes all disturbance ceased. A solution of boric acid was then introduced into the bladder, and lithotrity was practised without pain. Lithotrity was practised four times, owing to the number of uric acid stones in the bladder; a 10 per cent. solution of cocaine was employed. The second and fourth times 30 grammes of this solution were employed; 15 grammes only were employed the third time, this injection was therefore less successful. The dry *débris* weighed 7 grammes 50 centigrammes, a certain quantity of impalpable dust was carried away by the solutions. From these experiments Dr. Dubuc concludes that cocaine may be employed with beneficial results in operating for stone when the *débris* does not weigh more than 10 grammes.

In cases where the stones are large and hard, and furnish a considerable quantity of *débris*, chloroform is indicated. The solution of cocaine to be employed must depend on the condition of the mucous membrane of the bladder — 10 per cent. solutions in cases where the bladder is healthy; 5 per cent. in those where the vesical epithelium is unhealthy, and active absorption must be expected. In 15 per cent. solutions the symptoms of absorption are strongly manifested. In his experiments the author reserved part of the solutions of cocaine with which to bathe the neck of the bladder and the prostate region, from whence it penetrated into the urinary reservoir. In cases of vesical exploration a few grammes of the solution of cocaine introduced into the prostate region and the neck of the bladder procured great relief.

"Dr. Morrell Mackenzie (*London Medical Record*, No. 118, p. 133), says he has found the hydrochlorate of cocaine extremely useful in operations for the removal of nasal polypi. The solution should be applied to the whole of the mucous lining of the nasal fossa. About three minutes after the application an operation can be commenced. It is also most useful in cases of laryngeal phthisis, in which there is great odynophagia, owing to swelling of the epiglotis. Patients, who before could swallow only with extreme pain and difficulty, have been enabled, about ten minutes after the application, to swallow with perfect ease and comfort. Both for the larynx and for the nose a 20 per cent. solution of the drug is employed. The author thinks that a somewhat

weaker preparation would prove a valuable remedy in hay-fever."

"In a case of traumatic orchitis reported by Barenechea (*Rev. Médica de Chile e El Siglo Médico*).* attended with intense pain, for the relief of which 3 centigrammes of morphia had been injected hypodermically every six hours, immediate relief was obtained by the injection of 1 centigramme of muriate of cocaine at the external orifice of the inguinal canal. The cocaine was injected so as to come in contact with the elements of the cord. Within five minutes the patient was quite easy, an exploratory puncture was then made for fluid in the tunica vaginalis, the patient only complaining of the prick to the skin of the scrotum. Cocaine is generally supposed only to act when applied to the peripheral extremities of a nerve, but the author asserts that he has often extracted teeth from the lower jaw after injecting cocaine over the mental foramen, without pain. He thinks that it may prove possible to obtain anæsthesia of any region of the body by injecting cocaine over the course of the nerve having to do with the sensation of that region."

Dr. Lee, (*St. Louis Medical and Surgical Journal*, vol. xlviii, p. 349), says: "It may be interesting to relate the use to which I put cocaine, in the operation for phimosis. I used a grain of cocaine in a four per cent. solution. One half a grain was introduced hypodermically through the dorsum into the cellular tissue, about

* London Medical Record, No. 139, p. 24.

midway the prepuce and the solution thrown both forward and backward in the line of incision. Then a pledget of cotton was saturated and introduced under the prepuce. After 10 or 15 minutes, the operation was made and the patient stated that there was scarcely any pain."

"Dr. J. H. Simpson, in the *Lancet*, Jan. 1885, p. 226, reports that he removed two small nodules of scirrhus from a patient's breast by the help of a solution of cocaine. Three minims of a 4 per cent. solution were injected on each side of one nodule; and after waiting ten minutes, the author made an incision one inch and a half long, and removed the growth without causing any suffering. After closing the first wound, the author injected another three minims near the second nodule, and operated in the same way; the patient felt a little pain, as the operator had not allowed sufficient time for the third injection to take effect. No after-effects were felt, and both wounds healed by first intention."

In case of strabismus cocaine has proved its great value as an anæsthetic, rendering the operation a painless one; many cases have been reported and each operator declaring in favor of cocaine.

"Lennox Browne (*Medical Press and Circular*, Aug. 9, 1893.),* says: In performing the operation of tracheotomy he makes use of a hypodermic injection of cocaine in each side of the region where the trachea is

*International Medical Magazine, vol. ii, p. 868.

to be opened. Five or ten minims of a ten per cent. solution are injected, and seven to ten minutes allowed to elapse before beginning the operation. Cocaine diminishes the hemorrhage, quiets the breathing, and steadies the larynx. In only one case has the writer seen any toxic action, and that was at once remedied when a full flow of air was admitted to the lungs through the open trachea."

"Dr. Lopatin (*London Medical Record*), tried, also, the local application of a cocaine solution (one grain to one ounce of water, on a piece of cotton-wool) in a case of agonising toothache, with bright redness and considerable swelling of the gum and with profuse salivation, in a young lady. After two applications in half an hour, the toothache and salivation disappeared, giving place to numbness on the diseased side, and the patient fell asleep for the first time after three sleepless days and nights. On the next day, the hyperæmia of the gum was found diminished. The feeling of numbness gradually passed away in two days."

The demand made on the general practitioner for local anæsthesia will in the majority of cases be for the extraction of teeth; and if an absolutely safe anæsthetic can be found and rules for its proper use formulated, much time can be saved to the surgeon, and much inconvenience to the patient; also, thereby we can avoid general anæsthesia, and all its disagreeableness.

"G. E. Grevers (*Weekly v. h. Ned. Tij. v. Genecsk*, No. xvii), injects ten to fifteen minims of muriate of

cocaine into the fold between the gums and cheek near the tooth to be extracted, and thus makes the extraction painless, and that at the moment when the gums are insensitive. Of thirty-six extractions, thirty-two were completely painless; in four only very slight pain was felt."

"M. Bignon (*Nouveaux remèdes*,)* states that he has furnished a dentist with a twenty per cent. solution of benzoate of cocaine, and that, with the aid of this solution, the dentist has extracted a great number of teeth painlessly and without any unpleasant occurrence. He first injects two or three drops under the mucous membrane of the gum, on the inner side of the tooth. After waiting from forty seconds to a minute, he injects a like quantity at the same point, but pushing the syringe deeper — as far as the immediate neighborhood of the nerve. After waiting again for a minute, he made a third injection, of three drops, on the outer side, as deep as the second. At the end of another minute the tooth is extracted."

"Telschow is quoted as follows by the *Therapeutische Monatshefte*, in his observations with the use of cocaine in oral surgery:

The quantity used must depend upon the vigor of the patient; it will ordinarily vary from three-fifths to one and one-fifth grains; to the solution of cocaine Telschow adds a solution of carbolic acid 1 to 1000.

The injections should be made as nearly as possible

* New York Medical Journal, vol. xliii, p. 594.

to the nerve branches, as the effect is then more marked.

When possible, the injections should be made at the borders of the mucous membrane about the teeth; injections are also made in the distribution of the lingual, buccal, and labial nerves.

In about two minutes after the injections the mucous membrane may be separated from the teeth by a knife, and a 20 per cent. solution of cocaine may be pencilled between the teeth and the tissue separated.

In about three or five minutes the operation contemplated may be commenced; all pain may not be avoided, but no great suffering will ensue.

The unfavorable effects of cocaine were witnessed among nervous women and the aged only, and followed the use of large quantities; the best restoratives were five or six drops of amyl nitrite, and alcoholics."

"Mrs. Elena F. Vongl-Sviderskaia, a dentist of St. Petersburg, made communication (*Znbovratchebnyi Vestnik*)* on twenty-five cases of tooth-extraction, in which, to relieve the pain of the operation, she had employed injections of a 20 to 30 per cent. solution of cocaine. About a half of a syringeful (containing four-and-a-half grains of the alkaloid, when a 30 per cent. solution was used) was slowly injected into three points: into the process of the gum between the teeth, then under the gum on the buccal side of the tooth, and lastly, at a corresponding spot over the lingual side. After waiting from five to seven minutes extraction was pro-

* London Medical Record, No. 133, p. 304.

ceeded with, and in all cases there was great relief or complete absence of pain. As to accessory unpleasant symptoms from such a large dose of cocaine, there was noted only mental depression with drowsiness in one case, and intense oppression in the chest, dilatation of the pupils, acceleration af the pulse and breathing, and mental excitement in two others. The remaining twenty-two patients presented no toxic symptoms whatever."

"In a small pamphlet by George Vian,* he reports 86 cases of extraction of one or more teeth or roots during local anæsthesia, produced by subgingvival injections. In no case was any pain felt, nor were any ill effects subsequently noticed.

The author's discovery consists in using a carbolized solution of cocaine. He dissolved 0.05 gm. muriate of cocaine in 0.6 gm. of a two per cent. carbolic solution freshly each time, and injects half on either side of the tooth into the gum at a point situated between the neck and the tips of the root of the tooth. After three minutes complete anæsthesia results and the extraction can be made after five minutes.

He also experimented with pure carbolic solution and obtained good results by injection of 50 centigrammes of a two per cent. solution on each side of the tooth."

J. W. Hope, M.D., *Virginia Medical Monthly*, says: "As one of the great corps of "country doctors" who act in almost every capacity for their patrons. I sub-

*Annals of Surgery, vol. vii, p. 80.

mit the following formula as a local anæsthetic for the almost painless extraction of teeth:

℞—Hydrochlorate cocaine, 5 parts; Crystal. carbolic acid, 6 parts; Pine gum camphor, 6 parts; 95 per cent. alcohol q. s. to make 120 parts. Mix.

Inject one to three minims of this mixture with a hypodermic syringe, deeply into the gum on the inner and outer sides of the tooth. Apply over the gum a piece of absorbent cotton wet in the solution. Wait four or five minutes. The gum can then be freely incised, and the tooth drawn with a minimum amount of pain."

There have been many combinations with cocaine offered as a local anæsthetic for the painless extraction of teeth; many of them give satisfaction; some of these preparations, while they may destroy the pain which ordinarily attends the extraction of teeth, may, if used about the gums hypodermically, give rise to abscesses, which many times are accompanied by much soreness and swelling, and as we have observed, may continue for several days; while this condition of things would not be considered as dangerous to life, yet, it would by most operators be deemed sufficient to bar its use. We have in mind now a preparation, that proved a most excellent anæsthetic, but in nearly every case in which it was used much soreness and swelling resulted. It was composed of cocaine, chloral hydrate, and carbolic acid; the amount of each drug in the preparation was small, but the disagreeable effects from its use were large.

"Mr. Mago Robson, *Brit. Med. Jour.*, reports the

case of a patient suffering from a large varicocle which he desired removed. In this case one grain of cocaine was injected where the incision was desired. After ten minutes the operation was performed without any difficulty, and the patient experienced no pain. The wound healed by first intention."

"Professor Manassein,* of St. Petersburg has lately employed cocaine with signal success in sea-sickness on himself and a number of fellow-passengers. This fact induced him to test the efficacy of cocaine in the vomiting of tuberculosis. Although he has only given it during the short period of a fortnight, he already is able to record excellent results in three tuberculous patients suffering almost daily from distressing vomiting. He prescribed the cocaine in solution for swabbing the pharynx or for internal use, *e. g.* ℞. Cocaini muriatici, gr. viij; Aqua distill, ℥j—℥jss; Alcohol, q. s. (N. B. The alcohol is added in order to render the solution more stable.) From 5 to 10 minims are to be taken in water before or after meals, or at the time of the most violent attacks of coughing (usually in the morning and in the evening)."

"Dr. J. A. Wyeth, read a paper on cocaine in surgery as a local anæsthetic, (*Proceedings of the Medical Society of Virginia*),† in which he accords to Dr. Karl Koller, the credit due for its introduction for eye surgery, and to Dr. J. Leonard Corning, the credit for its

* London Medical Record. No. 127, p. 1.

† Virginia Medical Monthly, vol. xvi, p. 550.

practical application to other surgical purposes than anæsthesia for eye surgery, he remarked first upon its dangers, due to idiosyncrasy, etc. Its dosage is uncertain, differing widely, not only in different individuals, but in the same individual at different times. He spoke from personal experience and observation. The general rule should be to begin with the minimum dose, gradually increasing it, always watching the pulse, face, respiration and pupil. In small doses, it increases the number of respirations, and is a cardiac stimulant; in large doses, it arrests the heart in diastole, and the action of the respiratory muscles. Cocaine is never applicable to children under ten or twelve years of age. In his several hundred applications in adults in all parts of the body, he has several times observed pallor of the face and fainting, but due most probably to the patients being overcome by the sight of blood, etc. In some, however, it was due to absorption of the drug. Exhilaration is not an uncommon symptom, and in rare cases it increases to boisterousness. In one instance convulsive movements occurred, opisthotonos being rather well marked. In another case, a convulsion occurred 14 hours after a gradual injection of thirty minims of a four per cent. solution of cocaine (gr. jss). In many cases, when not applied about the eye, dilation of the pupil occurs, indicating absorption by the blood. For hypodermic purposes, he uses twenty grains of cocaine and three grains of boracic acid, dissolved in an ounce of distilled water — approximately, a four per cent. solution. A strong-

er aseptic solution in equal parts of distilled water and saturated solution of salicylic acid. Always dissolve cocaine in water free from lime.

In operations upon the extremities, the circulation may be temporarily arrested. For example, in amputation of the last phalanx of the finger, first immerse the hand for half an hour in a 1 : 2000 solution of corrosive sublimate. It is best not to Esmarch the finger, but to constrict it with a piece of rubber tubing. *Direct* injections (in the line of incision retard to a slight degree union and repair of wounds. Hence, employ the *indirect* method (injections about the nerves at the base of the finger) when possible, although this method requires a little longer time and a little more of the cocaine solution. Just before applying the rubber, insert the smallest size hypodermic needle through the skin on the lateral aspect of the dorsum of the digit, about an inch from and on the distal side of the ligature. Inject about two minims ; push the needle a quarter inch farther, and inject two minims more, etc., until the needle-point rests just beneath the skin, on the palmar aspect of the finger, when the same quantity is injected. Thus one-half of the finger is injected, and the operation is immediately repeated on the other half — the entire operation not occupying more than 30 seconds. A smarting, burning pain is felt as the fluid enters. Tighten the tourniquet at once, thus holding the solution at a standstill for absorption, which may be hastened by massage over the injected area. Insensibility super-

venes in about two minutes. Usually about 15 minims are sufficient, but 30 minims may be thus used safely.

The operation being finished, loosen the band *for only a minute*, which restores the circulation, and (under sublimate solution) the wounds bleed freely, thus giving escape to whatever of the solution the arterioles may have absorbed; but of course a certain amount is carried into the general circulation. Tighten the rubber again for about two or three minutes, and insert sutures and apply the dressing. Gradually accustom the general circulation to the cocaine by alternately loosening and tightening the tourniquet. The heart and nerve centers might be overwhelmed if the entire excess is suddenly let loose into the general circulation.

The advantages of the *direct* method are: Rapidity of anæsthesia; the small quantity of cocaine used; escape of much of the solution through the wound of incision. This method is preferable for incising felons, removing diseased nails, foreign bodies, etc. Indeed, any procedure where the necessary anæsthesia can be obtained by not more than a drachm of a four per cent. solution may be safely done with this agent by the direct method.

In operations upon the trunk, the immediate absorption of the solution renders greater precaution necessary. For instance, if a fatty tumor is to be removed, insert the needle into the deep layers of the skin (not subcutaneous fat) along the line of proposed incision, and inject half-minim or minim; advance the needle a quarter of an inch, and repeat the injection, and so on

as far as the needle will reach from the original puncture. Repeat the injections, if necessary, for a length of three inches until anæsthesia is established. The anæsthesia is evident by the pallor of the overlaying cuticle. Divide the skin through the middle of the anæsthetized line, and continue the dissection laterally until pain is experienced. Insensibility often spreads an inch or more on either side of this line. Inject a half minim or more at all sensitive points in the line of incision.

Since scars are to be avoided, cocaine is not so free from objections on the face and neck as elsewhere. In eye surgery, the uses of this agent are too well known to require remark. In the buccal cavity, it has a wider range of application. Tumors of a half inch to not more than an inch can be painlessly excised. Small epitheliomata or suspicious ulcers are painlessly removed from the tongue, when 5 to 20 minims of a 4 per cent. solution are injected beneath and around their bases. He has twice dissected out ranulæ successfully. Complete cleft of the soft palate in the adult can be painlessly closed by applying the solution to the mucous surface with a brush. Cocaine is in every day use for the larynx, nose and nasopharynx.

For internal urethrotomy, regardless of location, he rarely employs general anæsthesia now. Disinfect the urethra with boracic acid solution (gr. x to ℥j) ; inject ℥j—ij of a 4 per cent. solution of cocaine with the ordinary P syringe. At the end of a minute or so, let all

of the cocaine solution that will run out of the uretha run out. If the operation is to be in the membranous portion, pass the long curved tube of Otis into the part, and inject from 20 to 30 minims. For the introduction of the sound on the third day after urethrotomy, be careful not to over-distend the canal with the preliminary cocaine injection; about a drachm of the solution is then as much as should be used. For bladder examinations cocaine is very useful.

Circumcision in the adult no longer requires general narcosis. Constrict the penis near the pubes, pull forward the prepuce, and enter the hypodermic needle at the free border in the middle line on top, *between* the mucous and cutaneous layers. Then carry the point of the needle back as far as the proposed line of section, and force out one minim of the 4 per cent. solution. Withdraw the needle half way, carry forward again to the right and left, and force out a minim for every quarter of an inch of the line of section. On account of the sensitiveness about the frenum, it is best to inject two or three minims here.

In Levis' operation for hydrocele, cocainize the point where the trochar is to enter. If the hydrocele is small, Volkman's operation may also be done with cocaine anæsthesia. In the open operation for varicocle, cocaine is not sufficient; nor is it sufficient for external urethrotomy, cystotomy, hernia, etc. But small hemorrhoids may be injected or cut away after cocaine injections. Cocaine is sufficient also for fissures and ulcers of

the anus and rectum. It is also sufficient for a single and superficial anal and rectal fistulæ."

*"Of the various means of producing local anæsthesia, there is but one which has stood the test of time and use, and which, from the period of its first introduction, has steadily become more popular. Cocaine hydrochlorate, at first received with enthusiasm, then treated with distrust because of its toxic properties, with increased knowledge as to its proper use, has been steadily growing in favor, till the great majority of surgeons and practitioners constantly employ it in appropriate cases. Corning, by throwing an elastic ligature around the operative field immediately after the drug is injected, then on completion of the operation relaxing pressure so that venous bleeding occurs, hence, washing away of most of the injected fluid, is favored, has enabled the surgeon to inject much larger doses than were before considered safe. Even by this method, when the operation is at all extensive, injection of cocaine solution of an effective strength, and this must be at least one per cent., in sufficient quantity to anæsthetize the entire field of operation, implies the employment of a dangerous quantity of the drug. When the rubber ligature is used to prevent absorption, most surgeons prefer to use not more than a grain of cocaine; this allows the use of not more than twenty-five minims of a four per cent. solution, a quantity more than sufficient to thoroughly anæsthetize for such operations as the re-

*The Therapeutic Gazette, vol. xvi, p. 816.

moval of an ingrowing toe-nail, but not enough to affect large areas, such as have to be rendered non-sensitive in operations on superficial epitheliomata, for instance.

Schleich, after elaborate investigation upon the subject, has rendered cocaine anæsthesia, even when large surfaces are implicated and when major operations are performed, perfectly safe and satisfactory. He first observed that injections of distilled water produced anæsthesia, but loss of sensation was first preceded by so much pain that this method was not practicable. He then found that injection of normal salt solution (.75 per cent.) produced neither pain nor anæsthesia. It remained to find a solution between water and normal salt solution which would be painless and anæsthetic. A .2 per cent. salt solution was found to accomplish this result. The anæsthetic effect was, however, greatly heightened by the addition of even a very minute percentage of cocaine.

Schleich employs three solutions, according to the extent of the operative area. One contains one part of cocaine to 1000 parts of a .2 per cent. solution of sodium chloride in water. Two hundred minims of this mixture contain only one-fifth of a grain of cocaine. The second solution, for more extensive operations, contains one part of cocaine to 5000 parts of the salt solution; the third contains one part of cocaine to 10,000 parts of the solution. When these weaker solutions are employed, Schleich

uses large syringes, containing one or two ounces.

The whole operative field is completely infiltrated by means of as many injections as are necessary. The first injection is rendered painless by means of an ether spray. The following injections give no pain, since the needle is entered through anæsthetic areas.

In cases of operation upon bone, the periosteum must be injected, since pain is only experienced in this region. Schleich has performed five hundred and twenty-one operations, rendered painless by this method. Among these are to be numbered amputations of the breast, herniotomies, tracheotomies, radical operation for hydrocele, etc. He holds that the method is absolutely without danger. Cocaine intoxication never occurs, since very small quanties of cocaine are employed, and over one-half the injected fluid escapes as soon as the incision is made.

The success of this method depends upon injecting a liberal quantity of the mixture; indeed, Schleich terms it infiltration anæsthesia. When the solution is sterile, it can exert no harmful influence upon the tissues. It is likely to be found particularly serviceable in operations about the rectum and vagina, where the epithelial covering of the mucous membrane is so thick that surface applications of even powerful solutions of cocaine produced little or no benumbing effect. In office work, the method will be found most valuable, since it will enable the practitioner to locally anæsthetize without the slightest danger of exciting toxic symptoms in cases

which would need a quantity of cocaine so considerable as to excite fear in regard to constitutional effects."

In some cases it is desirable to obtain an anæsthetic condition of the part without using the solution hypodermically; in the case of a timid person is this especially desirable. We give a description of what is known as Wagner's method of inducing local anæsthesia.

"For the description of Wagner's method (*Centralbl. f. Therapie.*)* of producing anæsthesia of the skin by the combined action of cocaine and electricity. Wagner utilizes the so-called cataphoric property of the galvanic current, which enables him to render the skin anæsthetic over any wanted area, provided the epidermis is intact. The cataphoric action of the galvanic current depends upon its power to direct liquids contained in a porous receptacle from the anode to the kathode. The living tissue represents such a porous receptacle, and is well adapted to execute this cataphoric action of the current. The quantity of liquid moved in a certain unit of time is the greater the stronger the current and the poorer the conducting quality of the liquid is.

The application of this peculiar action of the galvanic current for the introduction of medicinal agents into the organism has been previously attempted by other experimenters without having furnished very encouraging results. This failure Wagner attributes to the choice of the employed drugs, which probably did not fulfil the requisite of being active in very small quanti-

* The Therapeutic Gazette, vol. x, p. 611.

ties without demanding a strict fixation of the dose. Cocaine answers fully to this requisite. Wagner's *modus operandi* for the production of anæsthesia consists in applying a flat electrode invested with leather or flannel and saturated with a solution of cocaine to the skin; this electrode is made the anode of a galvanic current of a medium strength. After a few minutes the electrode is removed, when the entire surface of the skin which was covered by the electrode will be found to be completely anæsthetic. The degree of anæsthesia is proportional to the strength and the duration of the current; its duration is from ten to fifteen minutes.

The larger the area to be anæsthetized the greater must be the strength of the current. Wagner uses a circular anode-electrode of two and a half centimetres and a five per cent. solution of cocaine with a current of six milliampères for four or five minutes. For the head and neck especially this strength suffices, while for the trunk and extremities currents of ten to fifteen milliampères should be employed.

If a deep anæsthesia is intended Wagner recommends to place the kathode diametrically opposite to the anode.

The quality of the cocaine solution influences the cataphoric effects only inasmuch as these are the greater the poorer the conducting quality of the solution is. A stronger solution is a better conductor than a weaker one, and therefore less eligible than the latter. On the other hand its higher degree of concentration warrants effects not anticipated from the use of a weaker so-

lution. It has not yet been ascertained whether or not the stated advantage and disadvantage equalize each other.

Wagner's practical experience with the procedure is limited though encouraging. Thus in a small operation he became convinced that incisions could be made through the entire thickness of the cutis without occasioning any pain. If the anæsthesia does not penetrate deeply enough, the deeper parts of the wound can, as suggested by Wagner, be rendered anæsthetic by applying the cocaine solution directly to them.

In the conclusion of his paper, Wagner refers to Corning's observation, if the Esmarch bandage is applied a little while after the injection. Applying the cocaine by the aid of electricity, Wagner confirmed Corning's observation, and found that the anæsthesia could be extended over one-half by the use of the Esmarch bandage."

The method of using cocaine solutions as suggested by Dr. J. Leonard Corning, is very plainly stated by him, *Philadelphia Medical Times*, vol. xvi, p. 326. "By experiment he had learned that, by shutting off the circulation from the part to be anæsthetized by hydrochlorate of cocaine, insensibility produced by the drug could be indefinitely prolonged. The reasons for this were not hard to conceive. We were thus enabled to reduce the constitutional symptoms to a minimum. Here were advantages not to be overestimated; for if, as in the ordinary method without incarceration of the

anæsthetic, we inject a sufficiently concentrated form to influence the general nervous system, there would be liability of establishing a change in the nerve-filaments of the brain and cord. In speaking of the very low percentage of cocaine which would produce anæsthesia when incarcerated, Dr. Corning had found a one-, a one-half-, a one-third-, and even a one-fifth-per-cent. solution of cocaine to produce insensibility. A one-fifth-per-cent. solution, however, is to weak for practical use. For ordinary purposes, a solution of one-half to one per cent. is most desirable.

In order to avoid injection of the solution into the lumen of large veins, Dr. Corning applied a moderately strong rubber band around the limb, obstructing the return circulation, and, having thus rendered the veins prominent, he mapped out their course with a soft blue pencil. This was the more important inasmuch as, after applying Esmarch's bandage and rendering the limb bloodless, preparatory for the injection, the course of the veins could not be seen. Having mapped out the veins, he rendered the part bloodless nearly up to the point of operation by Esmarch's bandage, then made the injection just below the margin of the tourniquet, which was tightened shortly after making the injection. At first, two to five minims of the fluid were injected just under the epidermis, and, having rendered the superficial parts insensitive, the needle could be made to penetrate more deeply without causing the patient more than trifling pain. The greater the extent of the operation, the

weaker should the solution be, if we wished to avoid producing constitutional symptoms. It was necessary to make the injections as rapidly as possible, in order to avoid deportation of the anæsthetic by the blood-stream before applying the tourniquet. The tourniquet should be applied just above the anæsthetic zone. The extent of the zone was measured by the æsthesiometric probe.

In case of operation upon the face and parts of the body where the tourniquet could not be employed, Dr. Corning made use of hæmostatic rings. These made pressure upon the integument surrounding the field which it was desired to operate upon, and while they did not so completely cut off the circulation as did the tourniquet, still they incarcerated the anæsthetic sufficiently to permit of a severe and protracted operation without danger of constitutional symptoms from the amount of cocaine used."

*"Determined to test the methods of Dr. Corning, Dr. McCarthy injected a half grain of cocaine in ten minims of water in my right forearm on the radial side. This was followed in five minutes by exsanguination of the arm from the fingers, making a long skip with the bandage at the point of injection, and compressing the brachial artery above the elbow. Before applying the bandage, the area of anæsthesia was 1 x 1 1-2 inch; twenty minutes later, after compression of the artery, it was only 1 3-4 x 3 inches, which gradually diminished. After the effects of this had worn off, the brachial artery was compressed above the elbow, and *one quarter*

*New York Medical Journal, vol. xliv, p. 168.

grain of cocaine injected into the ulnar side. Twenty minutes later a large sewing needle was inserted one inch straight into the arm without the least pain. Thirty minutes after the injection, the anæsthetic area was 5 x 8 inches for superficial and deep pricks of the needle. This method seems to have decided advantages over the first. In order to see what effect a deep injection would have, the artery was compressed as before, and the hypodermic needle inserted one inch straight into the tissues, and then one quarter grain slowly injected. Eight minutes later, the anæsthesia had only a diameter of half an inch long. In testing the sensibility in this experiment, the ulnar nerve was evidently injured, as proved by the fact that, on introducing the needle, an intense pain shot down the ulnar side of the arm, and that side was perfectly numb for more than forty minutes. As the area of insensibility did not extend, and the soreness of the flexor digitorum communis increased, this method of very deep injection was abandoned.

The opposite of this was tried—namely, a very superficial injection of one quarter grain just under the skin after compressing the artery. The area was long and narrow. Six minutes after injection, it measured 2 x 3 1-2 inches; fifteen minutes later, 2 x 6 1-2 inches."

We have taken at random from the best medical literature a number of cases of cocaine poisoning. A careful study of these shows that the toxic symptoms manifested in a majority of the cases were the result of a careless, not heedless, use of a very potent drug, and a

report of these cases should not influence against the proper use of this valuable agent.

"Dr. P. Heymann's case, *Berliner Med. Wochenschrift*,* which was described at a meeting of the Medical Society of Berlin is as follows. A boy, aged 6 1-2, suffered from papillomatous growths in the larynx, which had been repeatedly extirpated—once under the influence of cocaine; they rapidly reappeared, and required another operation. In order to produce local anæsthesia, Dr. Heymann resolved to bring the fauces and larynx completely under the action of cocaine. As at the previous operation, so also at this, an exceptionally large quantity of this drug was needed ere the desired effect took place. Five grammes (℈iv) of a 20 per cent. solution, *i. e.* 1 gramme (15 1-2 grains) of hydrochlorate of cocaine were gradually applied by means of a camel-hair brush; a considerable, but not measurable quantity, was swallowed, when the patient commenced to complain of giddiness and sickness. Anæsthesia had taken place, although not yet a complete cessation of reflex movements. The morbid growths were speedily removed; but, before the operation was terminated, the patient began swaying in the chair. Having immediately been laid on a couch, he remained in an apathetic, semi-comatose condition for about five hours. No hallucinations were observed. When spoken to, he replied distinctly and sensibly enough, but hesitatingly, and was astonished to find himself in a strange

* London Medical Record, No. 128, p. 51.

room. He could walk only with great effort, and when led, his gait was staggering and uncertain. He felt no desire for food, although his accustomed dinner-time had long passed. He neither complained of pain, nor any sensation of uneasiness. The pupils were not dilated, and reacted normally to light. He was able to read without difficulty. The cornea and skin were normally sensitive to touch. The anæsthesia of the fauces gradually wore off, and had completely ceased after two hours. The frequency of the pulse, which was very strong and full, was raised to about 100, and the respiration to 30; the temperature reached 38.2° C. (100.76° F.). In other respects, the action of the heart and the respiration were equal and quiet. This condition continued for more than five hours; the only change being that the patient became unable to walk, and that his legs felt benumbed and not under control; after which, the frequency of the pulse and of the respiration sufficiently abated for him to be safely conveyed home to his family. On his arrival there he was put to bed, but could not sleep until after five hours, when the greater part of his symptoms (his capability of walking was not tried) had ceased, and he ravenously demanded food. On awaking on the following morning he felt quite well, although looking pale; his appetite was normal, and no disturbances of digestion were noted."

"Dr. Mikhail J. Reich, *Russkaia Meditzina*,* records a case in which the employment of a 2 per cent. solu-

* London Medical Record, No. 127, p. 2.

tion of hydrochlorate of cocaine in the course of an ophthalmic operation gave rise to general toxic symptoms. In a girl, aged 10, who was undergoing iridectomy for leucoma, about twelve or fifteen drops of the solution were instilled (three drops at a time, at intervals of several minutes). The operation having been completed absolutely without pain, the patient returned home with her mother and immediately went to bed, as she felt very poorly; there appeared considerable prostration, paleness, nausea, and vomiting. On the next morning, however, the girl was brought to the author quite well and cheerful, the wound having been united."

"In a case reported by Mr. J. L. Callaghan, *Lancet*,* he states that a man applied a 4 per cent. solution of cocaine to a bad tooth. He swallowed some thirty to forty drops of this, and half an hour afterward he was seized with a feeling of faintness and giddiness; this was accompanied by an attack of palpitation. Numbness, tingling, and dryness of the throat were complained of, with a sense of flushing, especially up the back. There was marked diminution of smell; great difficulty in producing vomiting; a scarlatina-like rash over the body, especially about the neck; dimness of vision, relaxation of the sphincters, and weakness of the extremities. The mind remained clear, but the pulse was fast, weak, and intermittent."

"Montalti (*Lo Sperimentale*)† reports a case of a

* London Medical Record, No. 133, p. 304.

† London Medical Recorder, No. 164, p. 62.

woman who took, by mistake, 1 1-2 grammes of hydrochlorate of cocaine in solution. In about fifteen minutes she became delirious, complained of an obstruction in the throat, made efforts at vomiting, but did not eject anything. At the same time she was seized with a rigor so that it was necessary to apply hot cloths and warm the bed. Gradually she became more agitated, and commenced to have illusions of vision. Her face was pale, the pupils dilated, the lips cyanotic; she became pulseless and soon lost consciousness."

"Dr. L. G. Boughton, *North Carolina Medical Journal*,* reports the case of a young woman suffering from toothache who visited a dentist and had placed in the cavity of the tooth a bit of cotton with three drops of a 20 per cent. solution of cocaine. This relieved the pain and she went home, and feeling tired went to bed, her relatives seeing that she was ill, sent at once for Dr. Boughton. He visited the patient immediately and found her unconscious, with a pulse of 47 and respirations 12; right pupil (that on the side on which the cocaine had been used) was much dilated; she could not be roused from her state of insensibility. Brandy by the mouth and hypodermically failed to rouse her, so then he gave hypodermically 1-100 grain of strychnia, which had the effect of rallying her, and in two hours she was free from the effects of the cocaine."

Dr. Zambianchi, (*Gazz. degli Ospitali*,) † reports the

* London Medical Recorder, No. 164, p. 63.

† London Medical Recorder, No. 165, p. 111.

case of a lady who had been twice operated on for cancerous nodules of the breast; as operation was again necessitated by the recurrence of the disease in the skin of the thorax and the axillary glands. The patient was in fair health, and the heart sound. A 5 per cent solution of cocaine was prepared, and of this 4 1-2 Pravaz syringesful (0.222) were injected. Epileptiform convulsions immediately resulted, and lasted fifteen minutes. Artificial respiration was resorted to, and the patient seemed coming to. Convulsions, however, again supervened, and in five minutes the patient was dead."

"In the *Centralbl. für Chirurg.*,* a case is given in which 23 milligrammes were injected, for the removal of a small tumour in front of the right ear in a young man of 23. Within thirty seconds the patient became alarmingly weak, and shivered; pulse 140, cold sweat, collapse. Stimulants were freely given; after a quarter of an hour he began to rally, and finally recovered."

"Another, a fatal case (*ibid*,) was that of Dr. S. P. Colomnin's, professor of clinical surgery in the Military Academy of St. Petersburg. Wishing to scrape and cauterise a large rectal ulcer in a lady, he injected at four intervals a solution containing 1.50 grammes of hydrochlorate of cocaine. Complete anæsthesia was not obtained. Immediately after the operation the pulse was frequent. After three quarters of an hour Professor Colomnin was called, and found the patient very weak, with difficult respiration, hands and feet cyanotic. All

*London Medical Recorder, No. 165, p. 111.

the means adopted, including tracheotomy and inhalations of oxygen, could not prevent a fatal termination."

"M. Abadie, (*La Médicine Hypodermique*,* Patient, aged 71, female, who was to be operated on for entropion; injection of a 5 per cent. solution of cocaine containing the equivalent of about four centigrammes of cocaine. In five minutes the parts were anæsthetic and the operation performed without pain; in getting off the couch she staggered; arrived in the adjoining room she fell to the ground as if in a faint. Her respiration ceased, her face became cyanosed and her lips livid. Her tongue was drawn forward, and artificial respiration was commenced, and two injections of ether were administered. At the end of half an hour she was so far recovered that she could speak a few words, and she was then put to bed and given some caffeine; but in spite of all efforts she gradually sank and died five hours after receiving the injection of cocaine."

"The following case reported by Dr. Alex Randall, *Univ. Med. Magazine*,† of a boy aged six years, whose nares were much occluded by swelling of the turbinates. A pledget of cotton-wool dipped in a 4 per cent. solution of cocaine was applied on each side, the application being subsequently repeated. Ten minutes after leaving he became unable to walk, and the Dr. was speedily summoned. He found the child delirious, with some hallucinations, pupils widely dilated, face flushed, and

* London Medical Recorder, No. 167. p. 194.

† London Medical Recorder, No. 169, p. 283.

with marked tremor and some subsultus; the delirium persisted for some hours, and he then fell asleep and was practically well the next morning."

"G. Bockl (*Deutsche Monatsschr. fur Zahnheilkunde*,)* observed once out of some one hundred and forty cases of tooth extraction under cocaine alarming symptoms follow its use. He had injected six drops of a twenty per cent. solution into the gums and removed the tooth without pain. Ten minutes later the patient's gaze became fixed, and there was temporary visual defect, with slight delirium. Inhalation of nitrite of amyl quickly put an end to the symptoms, nor were there any bad after-effects. In a similar case reported by Schilling, of Nürnberg, in which the nervous symptoms were more marked, the effect of amyl nitrite was equally decisive."

"Dr. Slayter (*Brit. Med. Jour.*, No. 1417, p. 421.) related a case of cocaine poisoning. He had hypodermically injected 15 minims of a 10 per cent. solution of cocaine hydrochlorate into the toe of a patient previous to operation. In ten minutes the patient became cyanosed, and developed an epileptiform fit. This passed off after a few minutes, and the operation was proceeded with, but he remained dazed for a couple of hours, and suffered from pain and smarting in the eyes for twenty-four hours. He had never suffered from epilepsy."

"D. Mowat, M.D., (*Lancet*, No. 3398, p. 715.)

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*American Journal of the Medical Sciences, No. 184. N. S. p. 555.

reports the following case: G. M., aged twenty-nine, a tall, strong-looking man, had a small rodent ulcer below and to the outer side of the left lower eyelid. I removed the ulcer by two elliptical incisions, using cocaine as the anæsthetic. Three and a half minims of a 20 per cent. solution were injected hypodermically in two different places. The operation, which was absolutely painless, only lasted about two minutes, but the patient during the stitching of the wound began to show signs of faintness, followed by some alarming symptoms; extreme pallor, yawning, gasping for breath, and frequent sighing, succeeded by rigidity and coldness of the extremities. The hands were firmly clasped above the head, and could be separated only with great difficulty. His face was blue and pinched, the pupils were semi-dilated and inactive to light, and the pulse was feeble and rapid. For a little while the patient was incapable of answering the simplest question put to him. The muscles became relaxed, and the patellar reflex was found to be increased; there was no ankle clonus. On regaining his power of speech he said he felt he was dying, and asked to see his wife. The aromatic spirit of ammonia was freely administered to him, and he began to recover. His pulse became full and rapid, 120 per minute. The clonic spasms seized him several times afterwards, each one being weaker than the preceding one. A few minutes after the cessation of these spasms he presented all the symptoms usually seen in a person suffering from the effects of alcohol. On his recovery

he said he did not remember anything of the operation, but felt giddy.

I have used cocaine hypodermically pretty frequently, and in larger quantities than the above; but this is the only case where I have seen any evil effects follow its administration."

"In *Rev. International of Therapeutics and Pharmacology** Dr. Legain reported the following case: A., aged fourteen, male, robust, foreign body slightly embedded in corneal layers, used four drops of a one-per-cent. solution of cocaine, and repeated in three or four minutes. Almost immediately the young man complained of vertigo, precordial oppression, disturbed vision, and pallor. He fell back in his chair incapable of motion. The pulse became smaller and smaller and slower, 35 per minute. The pupil considerably dilated. These symptoms went off gradually by the use of cold affusions to the face and a drink of strong tea, and at the end of twenty minutes the man was in his usual condition. The total amount of cocaine used was four milligrammes (one-sixth grain), and part of that was washed away by the tears. Legain thinks that occurrences of this kind are more frequent than generally supposed, and that the external application of cocaine may not prove altogether harmless. Trousseau says that in his personal experience at his clinics where cocaine is used two thousand and five hundred or three thousand times during the year, no symptoms of poisoning have

* International Medical Magazine, vol. ii, p. 964.

been seen, even after serious operations on the eye. He thinks, however, that the drug may be more active on the conjunctiva than beneath it. He had one case of strabismus in private practice which presented, after repeated instilations, syncope, pallor, and vomiting, which he ascribed more to nervousness. He does not believe that cocaine produces any poisonous symptoms when used in this way. Beauvis ascribes the symptoms to idiosyncrasy."

The following case reported by Dr. A. N. Blodgett.* "A patient, aged twenty-three years, who had always been of good health, and was not addicted to the use or abuse of any stimulant or narcotic. Small growth on right side of face, about half an inch in front of, and on a level of the superior border of the tragus of the right ear. The patient at the time of operation was in perfect health, pulse sixty. A 12 per cent. solution of cocaine which had been specially prepared for this operation was used. Three minims were injected at two points, one in front and the other behind the tumor, care being taken to avoid the location of the facial nerve, the parotid gland, and the larger vascular channels of this region. Thirty seconds after the injection was made the patient began to complain of a feeling of great depression, a sensation of coldness, and of faintness. The patient rapidly became cyanosed, the breathing changed to a sighing character, the pulse was one hundred and forty and weak, the face was bathed in cold

*Boston Medical and Surgical Journal, vol. cxvii. p. 282.

perspiration, there were short periods of profound collapse with unconsciousness. The patient was assisted to a couch, where he soon became quite helpless. Stimulants were administered, the heat of the surface was maintained. At the expiration of a quarter of an hour the finger on the pulse showed a commencing improvement in the patient's condition. With the restoration of the organic functions, came a mild form of delirium, the patient talking incessantly upon all possible subjects, and apparently not realizing that he had been in any abnormal condition. Soon the pulse was reduced to eighty per minute, and the skin became warm. The delirium gradually subsided, and the patient slowly returned to his natural state. Another injection of two minims of cocaine was now made in the periphery of the tumor, and after waiting for a few minutes, the small growth was quickly and painlessly removed. The patient remained somewhat excited and was unusually loquacious for some hours afterward, but had no return of the collapse or any other sign of impending danger. I have thought that possibly the first injection was of too large amount, and by its sudden presence in the vascular system, may have dangerously affected the central organs of circulation, or the higher nervous centers. The latter would seem the most probable explanation, as the effect was developed with a degree of rapidity which I have never seen equalled by any other drug which I have ever used by sub-cutaneous injections. I was incredulous when the patient began to

complain of the effects of the injection, for I thought it too soon for any effect whatever to be produced, but the clammy perspiration, the lividity of the face, the accelerated pulse, the weakness, the loss of consciousness, the sighing respiration, and the general collapse proved that it was not fright alone, for the patient was not afraid of the drug; but that it was due to the action of the substance upon the most important structures of the body."

"A singular case of poisoning by cocaine is reported by Chobaut (*Lyon Medicale*).* A man, 72 years of age, suffering from hydrocele, was tapped, and, after successfully drawing off three hundred grammes of a somewhat greenish liquid (without causing the slightest loss of blood), 30 cubic centimetres of a three per cent. solution of cocaine were injected into the vaginal sac, followed by the introduction also of a solution of iodine. Eight minutes after the injections an attempt was made to remove the liquid from the sac, but without success. Fearing a possible poisoning, the author immediately resorted to inhalations of nitrite of amyl; but, in spite of such a measure, the patient, in the course of a few minutes more, presented the following symptoms: A general pallor, especially of the face; great præcordial distress; dyspnœa, with frequently interrupted inspirations; depression of spirits; general lassitude; a small, filiform pulse, with a frequency of 120 per minute; tendency to syncope. Restorative measures were then ap-

* The Therapeutic Gazette, vol. xvi, p. 625.

plied; sprinkling of the face with water and vinegar; black coffee internally. The patient was put to bed, and treated with external heat by means of hot bottles. The symptoms began to subside gradually, and disappeared in about one and a half hours, although the weakness and the general depression continued towards evening, the patient appearing as if he had been subjected to a great fatigue. During the night he complained of colicky pains, which lasted for about two hours, but no stools occurred; sleep was interrupted. The general weakness, accompanied with a frequent pulse (105 per minute), continued for about four days, and gradually disappeared. The patient recovered finally."

"In *La Médecine Hypodermique** Berger reports the following case in which there were toxic effects from the use of cocaine. A young man suffering from hydrocele, which had rapidly developed, was to be treated by aspiration and the subsequent injection of iodine. Previous to the injection of the iodine, the interne introduced into the sac a solution of cocaine representing about six grains. In a few minutes the anæsthetic liquid was withdrawn and immediately replaced by a solution of iodine. Shortly after the patient complained of malaise, there was extreme pallor of the face, the pupils were dilated, frothing at the mouth, and general convulsions were present."

"Dr. Samuel T. Earle (*Maryland Medical Jour-*

*The Therapeutic Gazette, vol. xvi, p. 266.

nal)* reports the case of a male suffering from hemorrhoids, both internal and external. It was decided to remove them by the clamp and cautery. To secure an anæsthetic condition he made use of about one drachm of a 4 per cent. solution of cocaine (about two grains) which was injected into the subcutaneous tissue around the anus. In about five minutes after the injection was made and before any other step was taken in operation, he complained of strange feelings in his legs, accompanied by a twitching of the muscles. Soon these twitchings amounted to general tetanic convulsive movements, which involved all the muscles, both of the trunk and extremities. This condition was immediately followed by a feeling of fullness in the head; became unconscious and remained so for about five minutes. The convulsive seizures gradually subsided, and there was a gradual return to consciousness, although he was somewhat dazed and drowsy for a time. Pulse weak; pupils slightly dilated. Altogether the attack lasted about half an hour; followed by full recovery."

"In another case reported by Dr. Earle, in an operation for hemorrhoids he used about five grains of cocaine in solution (degree of concentration not reported) by injection. In about fifteen minutes after the injection was made the patient was seized with violent general convulsive movements which were very strong, and more pronounced on the right side.

She had opisthotonos, entire loss of consciousness for

*The Therapeutic Gazette, vol. xii, p. 17.

about five minutes, after which it gradually returned, and seemed fully restored at the end of fifteen minutes. Asphyxia; muscles of the lower jaw violently convulsed; pupils unevenly dilated after consciousness began to return; mouth drawn to the right side; speech decidedly thickened for some minutes after her return to consciousness; respiration very labored, and at the height of the attack was arrested for some seconds; pulse very feeble; cutaneous surface decidedly blanched where not purple, until after consciousness began to return, when it alternately became flushed and pallid; she now broke out in a profuse sweat. There was great prostration following the attack and a disposition to sleep. She recovered entirely after several hours, and only complained of feeling tired. This patient had never had any nervous attack of any kind previously.

"Dr. Bullock* reports the case of a man, aged 24, in which he used about two drachms of a 4 per cent. solution of cocaine in a spray to the tonsils, he also used forty minims by injection, this was in order to obtain anæsthesia in tonsillotomy. The operation was successful, perfect anæsthesia being obtained and but very little blood lost. About three hours after he was seized with a severe headache and vertigo, soon followed by a burning sensation in his stomach, and nausea but no vomiting. His face became much flushed, respiration quite difficult, and finally delirium came on. About four hours after the time of operation he was tossing about

* Boston Medical and Surgical Journal, vol. cxvi, p. 575.

in bed in a half-unconscious condition, muttering to himself. Was able without great difficulty to rouse him sufficiently to answer questions, after which he quickly relapsed into his former condition. The pupils were widely dilated, there was some cyanosis of the face, but not of an extreme degree, respirations varied from ten to fourteen, pulse was 126 and very weak. Administered about an ℥ of brandy, and a few minutes later twenty drops of tincture of digitalis, which was vomited fifteen minutes later.

A sub-cutaneous injection of five grains of carbonate of ammonia, hot sinapisms to the chest and epigastric region, this was soon followed by some brandy and digitalis, by the mouth ; this time it was retained. In about twenty minutes the pulse grew stronger, beating 115, and the respirations less labored. Brandy and digitalis at frequent intervals, and six hours after the taking of the cocaine the patient dropped off into a quiet sleep. Pulse was 105 and quite strong, and respirations 18, while the cyanosis of the face had nearly disappeared. He slept quietly until 9 P.M., when he awoke and stated that he felt much better, but still had some headache. Pulse 95, respiration 20. He soon went to sleep again, and slept quietly the greater part of the night. The next morning, he complained of a good deal of numbness and tingling in the extremities, intense dryness of the throat, and blurred vision ; these symptoms gradually passed off during the day, and by night he was as well as before taking of the cocaine."

"Dr. Stickler (*Medical Record*) injected 5 drops of a twenty per cent. solution prior to opening a small cyst. It caused vertigo, headache, nausea, diarrhœa, and insomnia, which persisted for three days."

"Mr. R. S. Bowker reports a case where one drachm of a six per cent. solution of cocaine was instilled prior to and during enucleation of an eye. Thirty minutes after the first application she became very faint, face blanched, lips cyanosed; felt very sick; pulse rapid and feeble. She rallied, but two and a half hours later the doctor was hurriedly summoned. On my arrival she was better, though faint, with cold extremities and rapid pulse. Hot brandy and water, and she was soon all right. Less than four grains were used, and yet I think it would have taken but little more in this case to have caused a fatal result."

Dr. J. H. McIntyre reports a case* of poisoning by cocaine, as follows: "I was called by Dr. Nichols to assist him in a case of poisoning by cocaine.

The patient, an intelligent gentleman, about 40, of full habit, weight about 160 pounds, short in stature, of nervous sanguine temperament, lying upon the floor of his office with head supported by a chair cushion, a deathly pallor overspreading his countenance; pupils widely dilated; conjunctiva insensible to touch; slow, labored (sighing) respiration; pulse 140 or more to the minute; inability to articulate; making frequent requests (by signs) for water which when taken into the

*St. Louis Medical and Surgical Journal, vol. li, p. 16.

mouth he spat out, as he was wholly unable to swallow. This condition followed the injection of one-half grain of cocaine, which was given twenty minutes previously. The treatment in this case consisted in the hypodermic administration of spts. ammo. aromat., morphia and brandy, which was given at frequent intervals. Gradual improvement occurred, at the end of four hours he was carried home, and in about fourteen hours from the time of taking of cocaine he had fully recovered."

"Dr. G. O. Williams (*New York Medical Journal*)* reported that he injected one-half a grain of cocaine —three injections five minutes apart—for local anæsthesia, prior to removal of small tumor from forearm. Ten minutes after the last injection there were general numbness of forearm, excessive dryness of throat, pupils dilated, vision so disturbed that he could not distinguish acquaintances at forty feet, and his gait was staggering. Symptoms persisted two hours. Visual disorder and dry throat continued through a sleepless night, and toxic symptoms persisted, in part, for nearly a week."

In case one were so unfortunate as to meet with a case in which any toxic symptoms manifested themselves, it would be very desirable to know how best to overcome them and so remove the patient from all danger. The principal remedy which has been used in cases showing toxic symptoms, is nitrite of amyl by inhalation, which affects the vaso-dilators, and by

* The Therapeutic Gazette, vol. xii, p. 19.

such action increasing the peripheral circulation.

"Eloy, in the *Revue et de Clinique et de Thérapeutique*,* gives the following directions for the treatment of acute poisoning by cocaine. The patient is to be placed in a horizontal position in order to prevent syncope, and his face is to be bathed with cold water. If convulsions come on, cold should be applied to him. If asphyxia is present, flagellation, massage, and artificial respiration are to be resorted to, and if the respiration depends upon the tetanic contraction of the respiratory muscles inhalations of chloroform are to be employed. For the intense pallor it is well to give inhalations of nitrite of amyl, which will provoke vaso-motor dilatation and so diminish arterial pressure in the large vessels by increasing the peripheral circulation. Should these means prove insufficient, it may be well to administer to the patient strong coffee or caffeine, or, if swallowing is impossible, hypodermic injections of ether may be used. In other words, the entire object of the treatment is to moderate the reflex excitability of the nervous system, to sustain the heart, and to re-establish the equilibrium of the circulation. Therefore, the treatment of acute cocainism is to be particularly directed to the arterial system."

Dr. G. C. Smith† says: "Accidents from the use of cocaine have become so numerous that it is looked upon by some as too risky a drug to be administered. This is

* The Therapeutic Gazette, vol. xvi, p. 422.

† British Medical Journal, No. 1614, p. 1204.

a pity, since with caution it may be used without fear.

Patients should be prepared by giving them a drop of a 1 per cent. alcoholic solution of trinitrine a minute before administering the cocaine, repeating the dose at intervals if the pulse be not affected and no pain or fulness in the temporal region be felt. The trinitrine acts almost as rapidly and continues to affect the vaso-dilators for upwards of half an hour longer than nitrite of amyl, which Professor Lépine has proposed, but which, on account of its fleeting action, has failed to gratify the hopes to which it gave rise.

Professor Lépine has pointed out the importance of paying attention to the type of patient. The nervous are to be encouraged and calmed, the anæmic made to lie down before administering the drug, for thus, as Dujardin-Beaumetz points out, cerebral anæmia is avoided. Dr. Lépine's statistics show that in the neighborhood of the face it is unsafe to inject hypodermically more than 2 centigrammes (one-third of a grain) at a time, and not more than from 4 to 5 centigrammes should be allowed to come in contact with a mucous surface. By taking these precautions accident is guarded against."

Several surgeons of late have been making free use of the phenate of cocaine in place of the muriate as a local anæsthetic, applying it to the mucous surfaces, also using it hypodermically. It is claimed by many observers that it is a perfectly safe drug to use with patients who are suffering from a diseased condition of the kidneys or heart. That these conditions contraindicate the use of

the muriate is well known. We have not been able to find any cases of poisoning by this drug recorded, neither have we found one where any toxic symptoms were shown, therefore it would seem that the phenate was the superior preparation for the producing of local anæsthesia.

Dr. C. A. Veasey* says: "On account of the great similarity between the local effects of cocaine and those of phenol, both agents causing local anæsthesia, and because it had been proposed to make extemporaneous mixtures of the two drugs to lessen the systemic effect of the former, it occurred to Von Oefele to combine the two substances in such a way as to form a salt perhaps, which would have the anæsthetic action of both, with the slow-absorbing power of the latter.

In cocaine phenate I believe we have this desired result. It is prepared by Merck, and his description is as follows: 'It is a slightly colored substance of *thick-honey consistency*, which readily melts when heated, and whose percentage of cocaine alkaloid is 75. It is readily soluble in a 50 per cent. solution of alcohol. The solution has a faint odor of carbolic acid.'

It is extremely deliquescent, my attention having been directed to this quality by my friend Mr. Swartley, who prepared the various solutions for me; it is also soluble in albolene, one of the bland oils produced from the coal-tar group. The dose is from gr. 1-12 to gr. 1-6 by the stomach. Locally, 'it coagulates the albumin

* Medical News, vol. lxii, p. 345.

in the tissue, preventing the absorption of the cocaine, thereby prolonging the anæsthetic effect and lessening the danger of systemic poisoning.'

In this combination, therefore, we possess, theoretically, a drug which has local anæsthetic properties with slow absorbing power, and which should also be slightly antiseptic.

The one quality in particular that has been claimed for cocaine phenate is that it produces the local anæsthetic effect, without any systemic effect; so it is hoped that those members of the profession who have patients presenting an idiosyncrasy to the local use of the hydrochlorate will give the phenate a trial."

"Oefele (*Semaine Médicale*,)* states that the ischæmia and anæsthesia, which follow the local application of carbolic acid, led him to combine that substance with cocaine. He has found that the analgesic effect of the combination (phenate of cocaine) lasts longer than that produced by the other salts of cocaine, and that, moreover, there is less risk of poisoning, on account of the insolubility in watery liquids of the new salt. In some cases the analgesic effect continued for thirty-six hours. He has employed this remedy in alcoholic and ethereal solutions with advantage in inflammations of the nose and throat."

Dr. D. B. Kyle† says: "The length of time to produce anæsthesia is somewhat longer than that required

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* University Medical Magazine, vol. v, p. 938.

† The Therapeutic Gazette, vol. xvii, p. 19.

for the muriate; but, when once produced, it is more lasting. In the twenty-four cases reported, the average time was seven minutes, the total number of applications at different sittings being one hundred and fifty.

The astringent properties of cocaine are well known.

Having used the aqueous extract of witch-hazel with success in cases of nasal hemorrhage, I used this in making the test solutions.

As the phenate of cocaine is insoluble in the witch-hazel, I first dissolve it in alcohol, then added this to the witch-hazel.

An equally good combination is phenate of cocaine thirty grains, menthol fifteen grains, to one ounce of witch-hazel. This is, however, open to the objection of the bad after-effects of menthol, first causing contraction of the blood-vessels, which is afterwards followed by congestion, with decided irritation of the mucous membrane.

In comparing the phenate with the muriate of cocaine, I believe it to be as good a local anæsthetic, and in none of the one hundred and fifty applications of which I kept record, and I feel safe in saying as many more of which I kept no record, did I have symptoms of cocaine poisoning, nor did the patient complain of any bad after-effect.

Yet in three cases there was cardiac disease and in one albuminuria. These conditions are known to be especial contra-indications for the use of the muriate.

For operations involving the deeper tissue, the drug

must be used hypodermically, the eight per cent. solution usually producing sufficient anæsthesia. The alcoholic solutions give better results, but are more irritating."

A comparatively new drug is being used in the place of cocaine muriate for the production of anæsthesia locally and the preparation is giving good results in all cases in which it has been used. The drug to which we refer is that of Tropacocaine, a new alkaloid that has been recently (1891) isolated by Giesel from the leaves of a "Small-leaved Coca-plant" of Java.

Dr. A. P. Chadbourne,* says: From the presence of benzoyl-pseudo-tropeïn in a species of coca-plant, it might be expected to resemble cocaine in physiological action; but, on the other hand, its chemical constitution points to a physiological action not unlike that of atropin. Actual experiment has shown that benzoyl-pseudo-tropeïn is a powerful local anæsthetic, resembling, but not identical in local action with cocaine. In the eye it causes neither the ischæmic characteristic of the *true anæsthetics* (cocaine), nor the marked irritation and hyperæmia of the group of substances called by Liebreich *Anæsthetica dolorosa;* but is physiologically a connecting link between the two classes.

The synthetical hydrochlorate of the base, if dissolved in physiological salt solution, seldom causes even temporary smarting or hyperæmia; but the preparation made directly from the leaves is more irritating, prob-

*British Medical Journal, No. 1651, p. 402.

ably because of slight impurities. The alkaloid is almost insoluble in water, and the synthetical hydrochlorate of benzoyl-pseudo-tropeïn has been used in all experiments on which the present paper is based."

The author in speaking of the action of tropacocaine in the warm-blooded animals, says: "There seems to be very little variation in the severity of the toxic action of a given dose of tropacocaine in different rabbits, and the doses can therefore be more accurately determined than for frogs.

As already said, rabbits vary but little in the degree of susceptibility to tropacocaine, and the severity of the toxic action corresponds closely with the dose. There is, however, a marked individual variation in the kind of symptoms produced, and any one of several distinct series may be present. It will be found, however, that the action on the cerebrum, cerebellum, medulla oblongata, or spinal cord, when considered as a whole, does not vary, and the individual variation must therefore be in the relative susceptibility of the different elements (perhaps centre would be a better word) which make up these great divisions of the central nervous system. In the rabbit, therefore, individual variation in susceptibility is of kind rather than of degree; while after cocaine, and to a less degree after tropacocaine, frogs show individual variation in the degree and not in the kind of susceptibility. This distinction is not without a practical bearing, for variation in degree of susceptibility is often dangerous, as is shown by the unexpected

toxic cases from small doses of cocaine in medical practice, while variation in the kind of susceptibility might be confusing, but would be less likely to lead to serious results.

After repeated small doses there is first a period of cerebral stimulation, in some cases shown by activity and exaltation, in others by fear and attempts to hide. A quiet interval follows, with less and less frequent but voluntary and co-ordinate movements. Inco-ordination and extreme difficulty in maintaining the equilibrium are next seen, and soon give place to the convulsive stage. After moderate doses the convulsions are most severe and last longest. After large doses the convulsive stage is comparatively short, and coma with failure of the respiration and death develop quickly. As the respiration grows less and asphyxia increases, there is much salivation and accumulation of secretion in the air passages, especially in the trachea, and to a less degree in the lungs, as can be seen *post mortem*. Coma with diminution in the cutaneous reflex gradually replaces the convulsions, and death follows from failure of the respiration, the heart beating for some time after respiration has completely stopped.

Recovery is usually by a gradual passing off of the stupor, though rarely the preceding stages are seen in inverse order but of shorter duration.

With rabbits as with frogs the different parts of the central nervous system, beginning with most anterior and gradually extending posterad, seem to be first stim-

ulated and later depressed; death occurs, however, before the paralytic action has become as great as in frogs. The stimulation of the cerebrum, followed by loss of equilibrium, from the action on the cerebellum and medulla oblongata, have been already described. During the comatose stage the general stimulation of the cutaneous reflex passes into depression. The convulsions cease after division of the cord below the medulla, and show no tendency to return even if the animal is left quiet until recovery, nor can they be produced by artificial stimulation. With cocaine also no convulsive element was present, nor could it be produced artificially.

Comparing the results of over thirty experiments with a like number of cocaine control experiments, it seems that (1) tropacocaine causes complete local anæsthesia of the skin more quickly than cocaine; (2) the local anæsthesia lasts on the average longer than cocaine; (3) the extent of the anæsthesia is possibly greater with tropacocaine; (4) a one-half per cent. tropacocaine solution causes in most cases marked diminution in cutaneous reflex near the point of injection, but with a similar cocaine solution this is slight or absent. In one instance, however, a one per cent. cocaine solution seemed to act more quickly and powerfully than a similar solution of tropacocaine. In seven experiments with the same solution the reverse occurred.

These results show that tropacocaine acts more quickly on the rabbit's cornea than cocaine, and that both cause

complete anæsthesia. From the average of the experiments it seems that a weaker solution of tropacocaine than of cocaine will produce complete anæsthesia, but this is less certain when the experiments, and not the average, are compared.

Mydriasis was occasionally present, but was less constant than with cocaine.

Ischæmia was not seen. When the solution was made with a 6-10 per cent. physiological salt solution instead of with distilled water there was seldom any congestion. With distilled water the hyperæmia usually disappeared within a minute, and no other sign of irritation was noted, unless a few winks just after the solution was put into the eye can be so called.

The most important differences between the action of tropacocaine and cocaine on animals are probably the following:

1. Tropacocaine is less than one-half as toxic as cocaine.

2. The depressing action both on the cardiac motor ganglia and the heart muscle, especially the latter, is much greater with cocaine.

3. Local anæsthesia, both of the eye and skin, is much more quickly complete with tropacocaine, and is probably of longer duration.

4. Slight hyperæmia is occasionally present, but quickly disappears, while with cocaine only ischæmia is seen.

5. Mydriasis is usually absent, but always seems to be less than after cocaine.

6. Solutions of tropacocaine are moderately antiseptic, and retain their strength for at least two or three months. Cocaine solutions often begin to lose their activity when only three or four days old.

Professor Schweigger has most kindly allowed a thorough trial of the action of tropacocaine on the human eye to be made in his clinic, and after several months' use he makes the following comparison between it and cocaine: The muriate of tropacocaine causes complete anæsthesia more quickly than a cocaine solution of the same strength. This anæsthesia does not last as long as that produced by cocaine, but a drop or two of the solution can be added from time to time, and complete anæsthesia thus kept up as long as is necessary.

Mydriasis was occasionally seen, but only in slight degree. No ischæmia was present; on the contrary, in a few cases there was very slight congestion for a few seconds. A few patients spoke of slight smarting, but this disappeared almost immediately and was hardly greater than that from distilled water. Both of these symptoms are much less when the tropacocaine has been dissolved in physiological salt solution — 6-10 per cent. aqueous solutions of pure sodium chloride — instead of distilled water.

No harmful symptoms of any kind were seen, and in most cases tropacocaine seems to be as good — in some cases better — than cocaine. For the extraction of foreign bodies from the eye tropacocaine is preferable

to cocaine because of its quicker action, and iridectomy has been performed in less than two minutes after one or two drops of a three per cent. tropacocaine solution had been put upon the eye and without pain being felt by the patient.

Dr. Silex, first assistant of Professor Schweigger, has used tropacocaine in his practice and has obtained similar results. He has performed tenotomy in less than half a minute after applying a three per cent. tropacocaine solution, and the operation was painless. In all cases a three per cent. solution was used, and whether a weaker solution would give as good, or a stronger better results, is yet to be proved."

"Dr. Hugenschmidt (*La Semaine Médical*)* confirms the results of Chadbourne's experiments with tropacocaine. The ingestion of one-third to two-thirds of a grain produced no appreciable effect on an adult. When two-thirds of a grain were injected rapidly into the region of the lower maxilla, vertigo, uneasiness about the heart, and a marked fall of blood-pressure were observed within three minutes. This effect was transient, and in ten minutes the pulse returned to normal. Doses of one-third to two-thirds of a grain do not affect respiration, whereas it is easily affected by full doses of cocaine. The above doses produce no effect on the nervous system, whereas similar doses of cocaine often produce marked symptoms of anæmia. Tropacocaine exerts no influence on the vaso-motor system. Dr.

* University Medical Magazine, vol. v, p. 574.

Hugenschmidt believes that tropacocaine is likely to prove of great value as a local anæsthetic. He employed it as such in thirty-seven cases, never exceeding five-twelfths of a grain, usually in the following solution: ℞. Tropacocoine, gr. ij; Distilled water, ʒj. Sig. —Ten minims for an injection.

It is of the greatest importance that the injection should be made slowly. One-third of a grain was found sufficient to produce anæsthesia when the injection occupied fully a minute. With this dose no toxic symptoms were observed in the thirty-seven cases.

Dr. Hugenschmidt claims for tropacocaine the following advantages over cocaine:

(1) Being prepared synthetically, it is less liable to variation than cocaine which is obtained directly from the plant.

(2) In equal doses, consistent with the production of anæsthesia, tropacocaine is less toxic than cocaine, and exerts very little influence on the vital functions of the organism.

(3) Local anæsthesia is produced more rapidly with tropacocaine, and lasts the same time as that produced by cocaine.

(4) Tropacocaine being antiseptic, its solution can be kept unaltered for months, whereas solutions of cocaine have a tendency to undergo decomposition and lose their analgesic properties after four or five days."

In many instances surgeons have sought for some agent which could be used for the production of local an-

æsthesia, and which would not be followed by any bad results or disagreeable after-effects. Such claims have been made for water, but it has been found that while the injection of water may act as an anæsthetic for a limited time, the immediate effect of the injection is a very disagreeable smarting which may be obviated by the addition of a small quantity of common salt to the water before injecting, or by using for the injection the so-called physiological salt solution, which is made by the addition of one part sodium chloride to one hundred and thirty parts of distilled water; a solution which is sufficient for all practical purposes can be made by the addition of one drachm of sodium chloride to one pint of water. To obtain the best results from this injection it should be made into the skin, not into the tissues beneath; this injection does not cause an anæsthetic condition of the skin extending beyond the borders of the anæmic zone, therefore the use of water in this manner is very much restricted in surgery, although great good has resulted from its use hypodermically in neuralgic affections.

SUMMARY.

The use of intense cold as an agent for the production of anæsthesia locally has been attended with much success and in many instances it gives as good results as the use of any other agent. The degree of cold sufficient to induce the anæsthetic state in the part may be obtained by the use of finely pounded ice mixed with salt and the same applied directly to the part, or the mixture may be enclosed in a muslin bag or metallic receptacle which shall be brought into contact with the part to be acted upon so as to abstract the heat and congeal the tissues. For the same purpose are used quickly evaporating liquids which are sprayed upon the surface, among which may be mentioned, rhigolene, ether, bromide, and chloride of ethyl; the liquified carbonic acid gas has been used by some operators to obtain this condition, but the use of this agent requires one to have on hand a cylinder of the compressed gas, which is not practicable.

The application to the surface of liquids of various kinds and combinations have been tried, but these preparations while they have been useful in relieving hyperæsthetic conditions of the skin and mucous membranes they do not destroy sensibility of the part sufficiently to permit of painless cutting operations. Among these may be mentioned analine oil which Dr. Govan* states he has used with good and satisfactory results in minor surgery, although it is held by many observers

* Physician and Surgeon, vol. viii, p. 139.

to be poisonous and unsafe to use. The following will be found useful:

℞. Chloral,
Camphor, of each, - - ʒij;
Morphia sulp., - - - ʒss;
Chloroform, - - - - ʒj.

M.—Apply to the part with a camel's hair brush.

For destroying the sensibility of the gums for the painless extraction of teeth the following will be found of much service:

℞. Tinct. aconite,
Alcohol,
Chloroform, of each, ʒii.

M.—Apply by moistening a pledget of cotton and holding against the gums, if now the tooth be seized with a forcep which has been warmed the tooth may be drawn with a minimum amount of pain.

The following is of a similar character and will without doubt prove valuable in many cases:

℞. Camphor pulv., - - ʒvj;
Ether sulph., - - - ℥j.

M.—Apply this to the gum surrounding the tooth to be removed, when the gum appears white the tooth may be drawn with scarcely any pain.

We next in order take up those substances which are used not only on the skin, and mucous membranes, but are used hypodermically as well. The drug whose action we shall consider first is that of cocaine; a drug that has been used quite extensively, and the success

attending its use has been excellent, good, fairly good, and indifferent. The reason for such a condition of success or want of success may be found by a careful study of the reported cases. The writings of some on "Cocaine and its Effects" have been very misleading, as they have given it as their opinion that cocaine was not toxic except in large doses; that intoxication might occur in some, but that recovery was to be expected in all cases; these statements led to a careless use of it by some and they then learned that cocaine was a powerful drug and should be used with care in all cases. It has also been found that a given quantity of cocaine quickly introduced into the body produces effects not obtained if the dose or quantity be divided, in other words, if the solution be of a low per cent. the effect of a given quantity of the drug is not the same as that of the same quantity of the drug given in a more concentrated solution. The lower the per cent. of the solution, the less the liability of the injection being followed by disagreeable after-effects. Unfavorable results are often had when using these solutions from the fact of their being old, it having been repeatedly demonstrated that in using cocaine only those which have been freshly prepared should be used. From experience and from observation both we would advise that the solution used should never exceed one per cent. The object in using it being to obtain anæsthesia and not to ascertain, by trial the amount of cocaine necessary to give dangerous symptoms or to produce death.

The manner of using the injection should receive careful attention. The first article necessary to be obtained is a hypodermic syringe, and this should be so constructed that with it we can force the solution into dense tissue, if needful; the ordinary instrument being of no use if we desire to apply much pressure, because the packing in the ordinary syringe will not hold. The size of the needle is also of much importance; the finest needle to be obtained will prove the best, the point of the needle should be ground so that it can be used in the skin, the angle of the bevel of the point should not be of more than forty-five degrees; the needle should not be of great length, but it should be strengthened by a good collar.

In cases of amputation better results from the anæsthetic will be had if an Esmarch's bandage be used to confine the solution to the part, or if the operation be upon the fingers or toes a piece of rubber tubing will be found preferable. In the matter of injecting of the solution into the part to be operated upon, the use of a weak solution is best, and the tissues comprising the field of operation should be filled, or saturated with the solution, this will give anæsthesia and no danger from poisoning need be feared.

In using local anæsthesia for the extraction of teeth, the solution should be injected into the gum surrounding the tooth or teeth to be drawn; it should also be forced into the socket around the tooth; after which use the lancet and separate the gum from the tooth and then *draw* the tooth from the jaw, *drawing* in the line of the

least resistance. Do not attempt to move the tooth outward and inward to loosen it, *draw* in the line of the least resistance *slowly* and *steadily* and the tooth will be drawn without pain. Be gentle while working in a patient's mouth and do not try to remove a tooth quickly, unless you desire to give pain.

The strength of the solution should be carefully considered; plenty of formulæ are to be found scattered through the medical journals with full directions for their use. Many of these formulæ are useful, while some of them are dangerous because of the large amount of cocaine, or because of the combinations made with other substances.

We give the following formulæ which will be found sufficient for all purposes.

A solution of cocaine of sufficient strength for use in all ordinary operations may be made as follows:

℞. Cocaine hydrochlorate, - - gr. j;
Physiological salt solution, - ʒij.

Mix.—Inject into the part freely. No fears need be had of poisoning in using this solution as two hundred minims of this mixture contains only one-fifth grain of the drug.

The following formula is one that has given great satisfaction and with no ill results:

℞. Cocaine hydrochlorate, - - gr. iij;
Glycerite of carbolic acid, - m. iv;
Aquæ, - - - - - - - ʒij.

Mix.—This preparation may be used with confi-

dence, and with safety to the patient. One hundred minims of this solution represents only one-fourth grain of cocaine.

For use in cases of tooth extraction the following will be found of sufficient strength:

℞. Cocaine hydrochlorate, - gr. iij;
Alcohol, dil., - - - - - ʒiv;
Witch-hazel extract, - - ʒij.

Mix.—Inject into the gum surrounding the tooth, then force it into the socket. One hundred minims of this solution contains one-fourth grain of cocaine. The above may be changed by using the same amount of phenate of cocaine in place of the hydrochlorate if such be desired.

The following formula is one that is highly extolled by Dr. J. W. Hope, in cases of tooth extraction.

℞. Cocaine hydrochlorate, - - - 5 parts;
Crystal. carbolic acid, - - - 6 "
Pine gum camphor, - - - - 6 "
Alcohol, 95 per cent. q. s. to make 120 "

Mix.—Inject one to three minims of this mixture with a hypodermic syringe, deeply into the gum on the inner and outer sides of the tooth. Apply over the gum a piece of absorbent cotton wet in the solution, and after a wait of four or five minutes, the gum may be incised and the tooth drawn.

If a formula for tropacocaine be desired, the following may be used:

℞. Tropacocaine, - - - gr. ij;
Aquæ, - - - - - - - ℥j.

Mix.—Ten minims of this may be used for an injection. This is a strong solution, and in most cases a solution of one-half or one-fourth the strength of the above will prove satisfactory as an anæsthetic.

The physiological salt solution for injection, or for use in the place of water in the previous formulæ may be made as follows:

℞. Sodium chloride, - - gr. xxx;
Distilled water, - - ℥viij.
Mix.

In using any preparation of cocaine or tropacocaine, use a fresh solution of known strength; use a syringe that you can force the solution into the tissues with; use only sufficient of the drug to produce anæsthesia; if the patient either from idiosyncrasy or an over-dose of the drug shows toxic symptoms, combat these by inhalations of nitrite of amyl, or nitroglycerin by the mouth, and place the patient in the recumbent posture.

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